


THE ELECTRIC POWER INDUSTRY IN JAPAN 2019

JEPIC
JAPAN ELECTRIC POWER INFORMATION CENTER, INC.

EPCo Distribution Areas and Frequency (As of January 2019)

JEPIC's member companies include the 10 EPCos indicated on the map and two wholesale electric utilities, J-POWER and the Japan Atomic Power Company.

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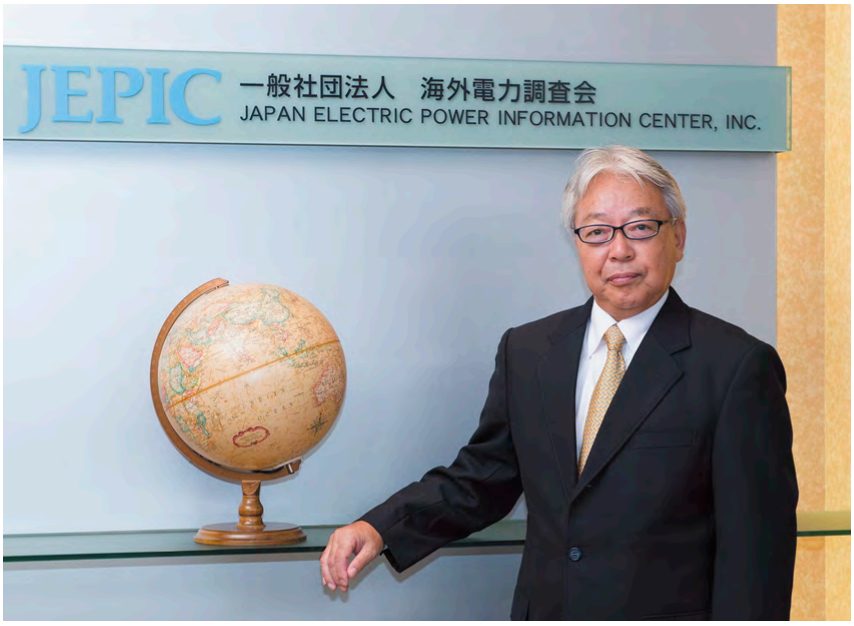
MESSAGE FROM THE CHAIRMAN



As the Chairman of the Japan Electric Power Information Center (JEPIC), I am delighted to present this year's edition of *The Electric Power Industry in Japan*(EPIJ). JEPIC's activities range from conducting research on the world's electric power industries to collaborating and cooperating with agencies and organizations involved with the industry around the world. This report was produced to provide our overseas readers with a better understanding of the electric power industry in Japan.

"This pamphlet has been prepared for the purpose of introducing abroad the present status of the electric power industry in Japan. Years have passed since the termination of the war; during which period Japan has seen the arrival of the threshold of industrial rehabilitation that has led the nation to a new era of its economic expansion."

Thus began the introduction to the very first edition of EPIJ, published in 1959. This year marks the 60th anniversary of this publication. Japan's electric power industry has changed immensely during those six decades. EPIJ, too, has evolved considerably since that first edition, and the contents of this report have been gradually updated and improved to better reflect changes in society and the industry. However, throughout all this time, our goal has always been to keep our overseas readers informed about Japan's electric power industry.

I observed that the nation's electric power industry has changed considerably. Sixty years ago, electricity demand soared as Japan's economy grew, and power sources and transmission facilities were rapidly developed and expanded to keep pace.

Change in the industry began with the shift from hydropower to thermal power as the main means of generating electricity in Japan from the latter half of the 1960s. This was followed by the oil crises of 1973 and 1979, which caused the nominal import price of crude oil to soar approximately tenfold between 1972 and 1979. In 1973, over 60% of the plants generating power for the electric power industry were oil-fired. Given that Japan produces virtually no oil of its own, it should not be hard to imagine how much turmoil these crises caused. This was also a time when air pollution resulting from an overdependence on oil was gradually emerging as a major social issue. Since then, the diversification of power sources (centered particularly on the expansion of liquified natural gas (LNG) and nuclear power plants) and the attainment of the "optimal energy mix" for the nation have been key principles guiding the development of Japan's electricity facilities.

In time, the previous steep rise in electricity demand slowed, and with the modernization of facilities largely complete, deregulation of the industry commenced with the approval of the entry of independent power producers (IPPs) in 1995. This was followed by the phased deregulation of rates for larger electric power users in 2000 and 2005, and the approval of new entries to the retail market. Full deregulation of the retail electricity sector was completed in 2016, and now the next major change to the industry will come in 2020 with the legal separation of transmission and distribution from the vertically integrated business. This step will transform the vertically integrated structure that has characterized Japan's electric power industry since 1951.

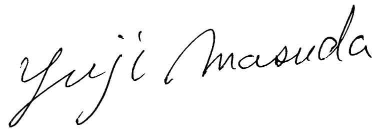
That, in outline, is how Japan's electric power industry has evolved over the past 60 years. What must not be forgotten, however, is the 2011 accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant (Fukushima Daiichi Accident). Public access to some of the land around the plant remains restricted, and residents in the area have had to be evacuated. At one point all of Japan's nuclear power plants were shut down, and some nuclear power generating units have since been decommissioned. Meanwhile, the Basic Energy Plan unveiled by the government in July 2018 reaffirms that nuclear power is to remain a key baseload power source for the nation while calling for renewables to be developed to function as a core power source. Regarding nuclear power, Japan's electric power utilities are working hard to further improve safety by complying with the tough new regulatory standards, and as a result, plants have been gradually coming back online.

The Fukushima Daiichi Accident was triggered by a natural disaster of historic proportions. However, last year, too, saw a number of major natural disasters in Japan, including landslides caused by torrential rain, typhoons, and earthquakes. Many lives were lost and homes and property destroyed as a result of these catastrophes. The electric power industry, too, was severely affected, as the earthquakes and typhoons caused widespread power outages around the country.

While I believe that Japan is a marvelous country with much that we can and should be proud of, the events of last year are a reminder that severe natural disasters are an inevitable part of our life here. In Japan as elsewhere, it is impossible for the electric power industry, given the huge scale of its facilities, to escape the impact of natural disasters. Despite the major damage caused by last year's power outages in various parts of the country, services have now been restored thanks to the unstinting efforts made by the utilities and the prompt support provided by other companies. Here I must pay tribute to all of those involved in providing the stable supply of electricity, not only here in Japan but all around the world.

As I noted above, full deregulation of the electricity retail market (including the residential sector and other small-scale customers) was completed in 2016. The environment surrounding the industry will be further transformed by the legal separation of transmission and distribution from the vertically integrated business in 2020. However, the importance of electricity to society, and the expectations for its stable supply, have not declined in the least.

Japan's electric power industry faces a wide range of challenges, including the restart of nuclear power plants, further improvement of environmental friendliness, and growing market competition. History, however, shows us that the industry has faced and overcome a variety of challenges over the past 60 years. I am confident that in another 60 years electric power will still serve as the bedrock of social affluence, and will still contribute to people's happiness all around the world.



Yuji Masuda
Chairman and CEO
Japan Electric Power Information Center

EXECUTIVE SUMMARY

ENERGY POLICY

- Under the Basic Act on Energy Policy, the Japanese government is responsible for formulating the Basic Energy Plan which sets the fundamental policy regarding the nation's energy supply and demand.
- The first Basic Energy Plan was formulated in October 2003, with updated plans prepared in subsequent years. Reflecting the lessons learned from the Great East Japan Earthquake and the accident at the Tokyo Electric Power Company (Tokyo EPCo) Fukushima Daiichi Nuclear Power Plant (Fukushima Daiichi Accident) in 2011, the fourth Basic Energy Plan incorporating major revisions was drawn up in April 2014.
- The fifth and most recent Basic Energy Plan was adopted in July 2018. In addition to the previously established basic goals of the "3Es"—Energy security, Economic efficiency, and Environmental acceptability—the new plan sets an overarching goal of achieving the "3E+S"—the 3Es plus safety (S). It further calls for the achievement of the Long-term Energy Supply and Demand Outlook ("2030 energy mix") laid out in the fourth Basic Energy Plan, and presents an additional "2050 energy scenario" to serve as a new national goal.
- The "2030 energy mix" serves as a forecast for Japan's supply and demand structure in fiscal 2030, laid out as a goal of the fifth Basic Energy Plan. Regarding the nation's power generation mix, the 2030 energy mix sets forth a policy to reduce Japan's fossil fuel dependence through energy conservation. It also aims to increase the share of renewables in Japan's power generation mix to around 22%-24% by the year 2030.

ELECTRICITY SYSTEM REFORM

- Following on the power shortages caused by the Great East Japan Earthquake and the Fukushima Daiichi Accident, the government established the Expert Committee on Electricity System Reform in January 2012. The Committee initiated a study of the electricity system reforms required in order to achieve the goals of securing a resilient power supply, suppressing electricity rate increases as much as possible, and expanding both consumer choice and business opportunities for existing electric utilities and newcomers.
- Based on the Committee's report, the Policy on Electricity System Reform was approved by the Cabinet in April 2013. This policy established a three-phase reform process to be implemented in the following order: (1) expansion of cross-regional grid operation; (2) full liberalization of retail market entry; and (3) legal separation of transmission and distribution from the vertically integrated business.
- In line with the new policy, the government subsequently implemented a phased revision of the Electricity Business Act and, in accordance with the revised Act, in 2015 established the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) and the Electricity Market Surveillance Commission. Full liberalization of Japan's electricity retail market was implemented in 2016, and preparations are now underway for the legal separation of transmission and distribution from the vertically integrated business.

NUCLEAR ENERGY

Position of Nuclear Power Generation in Government Policy

- Japan's energy self-sufficiency ratio in 2016 was only around 8%, and fundamental structural weaknesses remain. Moreover, efforts have been required in recent years to reduce the nation's emissions of greenhouse gases. In light of these circumstances, the fifth Basic Energy Plan approved by the Cabinet in July 2018 identifies nuclear power as an important baseload power source and sets a target for its share of the 2030 energy mix of 20%-22%. Nuclear power generation is also identified as "an option for decarbonization that is at the practical stage" in the long-term future energy scenario for 2050.

Action on Regulation of Nuclear Safety

- One of the lessons learned from the Fukushima Daiichi Accident was the negative impact of the compartmentalization of public administration. In September 2012 the Japanese government established the Nuclear Regulation Authority (NRA), and further created the Nuclear Regulatory Agency to serve as the authority's secretariat.

Through this reorganization, affairs concerning nuclear safety regulation that used to fall under the jurisdiction of multiple agencies were centralized under the independent NRA.

- Following the Fukushima Daiichi Accident, additional steps were taken to strengthen nuclear safety regulation. These included, 1) reinforcement of strategies for responding to severe accidents, 2) introduction of a "backfitting" program, and 3) introduction of procedures for extending the period of operation of nuclear reactors. This revision led to the entry into effect in July 2013 of new regulatory standards.

State of Nuclear Power Generation

- From May 2012 on, none of Japan's nuclear power plants were in operation. However, it was decided that plants determined to be in compliance with the new regulatory standards could be restarted. As of September 2018, 15 nuclear reactors had been confirmed compliant following the implementation of measures to strengthen their defenses against natural disasters such as earthquakes and tsunami, preparedness for severe accidents, and countermeasures against terrorism. Nine pressurized water reactors (PWR) have been restarted and have reentered commercial service. In addition to PWRs, some boiling water reactors (BWR) have also been confirmed compliant, with six additional reactors in all being prepared to come back online pending local approval and the completion of safety improvement work. On the other hand, at Fukushima Daiichi Nuclear Power Plant it was decided to decommission all of the plant's reactors, including those that had not been damaged in the accident. The decision was also made to decommission several other reactors elsewhere in Japan in view of the excessive cost of ensuring their compliance with the new regulatory standards.
- The period of allowed operation of nuclear reactors in Japan had previously been set at 40 years from their time of entry into operation. However, procedures have now been introduced allowing a one-time extension of this period for up to 20 additional years. As of October 2018, extensions had been obtained for three PWR reactors, and work is now underway to enhance their safety. In addition, an extension for the BWR at Japan Atomic Power Company's Tokai No. 2 Nuclear Power Plant was approved in November 2018, the first BWR to receive approval.

The Nuclear Fuel Cycle

- As Japan is dependent on imports for the bulk of its energy resources, a basic policy of the government has been to establish a nuclear fuel cycle in order to reprocess spent fuel and reuse the recovered plutonium and uranium as fuel. Spent fuel reprocessing is central to this plan. In October 2016 the Nuclear Reprocessing Organization of Japan was established to manage the necessary funds and to reliably perform reprocessing work and related activities. Japan Nuclear Fuel Limited (JNFL) was assigned to perform this work on an outsourcing basis. At the same time, Japan is also committed to working at the state level to reduce the size of its plutonium stockpile from the standpoint of nuclear non-proliferation.
- In July 2017, the Ministry of Economy, Trade and Industry (METI) published the Nationwide Map of Scientific Features for Geological Disposal as a preparatory step toward the final disposal of high-level radioactive waste. The government plans to narrow down the number of candidate sites based on this map.

Decommissioning Work at Fukushima Daiichi Nuclear Power Plant

- Recovery from the damage caused by the Fukushima Daiichi Accident, smoothly decommissioning the Fukushima Daiichi Nuclear Power Plant itself, and dealing with the problem of contaminated water are all perceived as top priorities for the government and Tokyo EPCo.
- When the accident occurred, it was decided in the interests of risk mitigation to remove the spent fuel then being stored in spent fuel storage pools from the pools at Units 1–4 and to store it appropriately in a shared pool at the site. The removal of spent fuel from the pool in Unit 4, where the most spent fuel was stored at the time of the accident, was completed in December 2014. In Units 1, 2, and 3, rubble that has been impeding the removal of fuel is still being cleared. A domed roof has been completed over Unit 3, and work is underway to extract fuel.
- Extensive "fuel debris," consisting of fuel and internal reactor structures that melted during the accident and then cooled and solidified, is believed to be present in Units 1, 2, and 3. Because of the extremely high levels of radiation in the reactor buildings, surveys of the interiors are presently being conducted using remote-controlled equipment.
- Water is being injected continuously into the reactors to cool the fuel debris. Consequently, more contaminated

water is being generated by the day as a result of the cooling water mixing with groundwater that has penetrated the reactor buildings. Various countermeasures are now being pursued to address this problem in line with the three principles of (1) the removal of sources of contamination; (2) the isolation of water from contamination sources; and (3) the containment of contaminated water. An impermeable wall of frozen soil has also been created around the plant to isolate groundwater from the contamination source, with freezing of the entire circumference commencing in August 2017. New emissions of contaminated water must still be stored in tanks following treatment by an advanced liquid processing system (ALPS). Land for tanks is growing scarce, and the government is leading a wide-ranging study examining social impacts as well as scientific safety in order to determine how best to dispose of water that has undergone ALPS treatment but still contains tritium that cannot be removed.

- Decommissioning work will continue over a prolonged period. This makes it important to create safe and secure working conditions, and steps have been taken to reduce the radiation doses to which personnel are exposed. As of September 2018, the areas where full-face masks no longer have to be worn had been expanded to cover approximately 96% of the site, improving the work environment in these areas and allowing work to be performed in ordinary work clothes and disposable face masks.
- Evacuation orders for areas near the plant are being progressively lifted. However, there still remain some areas where residents cannot return.
- In November 2017, a special zone for reconstruction and revitalization was designated in the town of Okuma and concrete plans put into effect to decontaminate the area and rebuild infrastructure in an integrated fashion so that evacuation orders could be lifted. The government is committed to ultimately lifting all evacuation orders, recovering from the damage, and restoring the region, no matter how long it may take.

RENEWABLE ENERGY

- The government launched the FIT (feed-in tariff) scheme for renewable energy in July 2012. Under this scheme, electric utilities are required to purchase all energy produced from renewable energy sources (including small- and medium-scale hydropower plants with a capacity under 30 MW). This scheme accelerated capital investment in renewables, with installed capacity compared to before the launch of the scheme growing by 41,480 MW by the end of March 2018.
- However, there is a growing issue with projects, particularly solar power projects, that are still not in operation despite having received FIT certification following the 2012 program launch. The government is considering revisions to the scheme to address this problem.
- In addition, while the FIT purchase price, especially for solar, has continued to fall, it still remains high by global standards, leading to calls for correction. The surcharge for fiscal 2018 is 2.90 yen per kWh (2.3734 trillion yen for Japan as a whole), or 9,048 yen per year for the standard model household.
- In order to prompt a price correction, since fiscal 2017 two tenders have been held for electricity purchases from solar power plants with a capacity of 2 MW or more. However, the results have been less successful than anticipated, with none of the proposals received for the second tender coming in below the price set by the government.
- Due to the rapid increase in connected solar capacity in Kyushu EPCo's service area, output controls, which had heretofore been used only on remote islands, were imposed on mainland FIT operators for the first time ever in October 2018.

GLOBAL WARMING COUNTERMEASURES

- In fiscal 2016, Japan's greenhouse gas (GHG) emissions measured 1,307 million tons (CO_2 equivalent), a decrease of 1.2% from fiscal 2015 and a 7.3% decrease from fiscal 2013. Of these, CO_2 emissions totaled 1,206 million tons (1.6% lower than in fiscal 2015, and 8.3% lower than in fiscal 2013). Factors behind the decrease in CO_2 emissions from the previous fiscal year included both lower energy consumption due in particular to energy conservation and a proportional increase in the use of non-fossil fuels.
- Ahead of COP21, held in Paris in December 2015, the government drafted an Intended Nationally Determined Contribution (INDC) target of reducing GHG emissions by 26.0% in fiscal 2030 compared with fiscal 2013

(25.4% compared with fiscal 2005) and submitted this target to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat.
- In order to attain the mid-term targets set forth in the Intended Nationally Determined Contribution, the Japanese government approved a Global Warming Countermeasures Plan at a meeting of the Cabinet in May 2016, resolving to effectively employ a wide range of policy instruments and steadily implement policies in order to facilitate global warming countermeasures.

ELECTRICITY SUPPLY STRUCTURE

- After World War II, 10 vertically integrated investor-owned electric power companies supplied electric power in Japan through regional monopolies.
- Entry into electricity wholesale services was liberalized in 1995, followed by the liberalization of retail electricity supply for customers receiving extra high-voltage (20 kV or above) in 2000. Retail supply liberalization was extended to large high-voltage customers (500 kW or above) in 2004, followed by all high-voltage customers (50 kW or above) in 2005. The market was fully deregulated in April 2016.
- Electric power generated in fiscal 2016 came to 998.1 TWh, and power consumption totaled 963.1 TWh.
- Peak power demand in fiscal 2016 was 155,890 MW.
- Total domestic generating capacity (including non-utility power) at the end of March 2017 totaled 298,350 MW. Domestic generating capacity (excepting non-utility power) totaled nuclear power at 41,480 MW (38,570 MW as of the end of September 2018), hydro power at 49,520 MW, and thermal power at 174,390 MW. Nationwide solar power generating capacity (including systems operated by non-utility generators) as of the end of December 2017 was 42,800 MW. Wind power was 3,370 MW.
- The Supply Plan published by OCCTO at the end of March 2018 calls for the development of 23,500 MW of new power sources from fiscal 2018 to the end of fiscal 2027. The breakdown of power generation by volume calls for 17,420 MW to be provided by thermal power generation, 279 MW to be provided by hydro power generation, and 5,806 MW to be provided by renewable energies excluding hydro.
- The power grid in eastern Japan runs on 50 Hz and the power grid in western Japan runs on 60 Hz. These eastern and western Japan grids are interconnected at three frequency converter stations capable of converting a total of 1,200 MW: Sakuma in Shizuoka Prefecture (300 MW), Shin-Shinano in Nagano Prefecture (600 MW) and Higashi Shimizu in Shizuoka Prefecture (300 MW). A decision has already been made to increase the interconnection capacity of these frequency converters to 2,100 MW by fiscal 2020, and to further increase the interconnection capacity to 3,000 MW, with operations targeted to begin in fiscal 2027.

ELECTRICITY RATES AND MARKETING ACTIVITIES

- Beginning in April 2016, in addition to high-voltage consumers to whom deregulation was already applicable, all other consumers including households became able to select between incumbent electric power companies' regulated rates and other rates plans, as well as unregulated rates plans provided by new electric power providers.
- As of the end of June 2018, the cumulative number of customers switching to new electricity plans since March 2016 totaled approximately 7.06 million, meaning 11.3% of ordinary general household customers had switched to new contracts.
- Following full deregulation of the market, the incumbent electric power companies and new electric power providers have been introducing a variety of electricity rate schedules designed to meet the needs and lifestyles of consumers with the aim of persuading them to select their services.
- To ensure that consumers make such selections appropriately, in January 2016 the Electricity and Gas Market Surveillance Commission formulated the Guidelines Concerning the Management of the Electricity Retail Business. The guidelines provide guidance to retail supply businesses and other related businesses on compliance with the applicable laws and regulations, and encourage them to engage in voluntary initiatives to ensure compliance.

I. ENERGY POLICY

1. Energy Policy Overview

(1) Basic Act on Energy Policy

Basic policy on energy supply and demand in Japan is determined under the Basic Act on Energy Policy, which entered into effect in June 2002. This act lays down the overarching principles framing energy policy—namely, the securing of stable supply, environmental suitability, and utilization of market mechanisms. It further specifies the responsibilities of central and local government and suppliers and the public's "duty of effort" necessary to implement these principles (Table 1.1).

Table 1.1 Basic Act on Energy Policy (Excerpts)

Article	Key Points
Article 1: Purpose	The purpose of this Act is […] to promote measures on energy supply and demand on a long-term, comprehensive and systematic basis by laying down the basic policy and clarifying the responsibilities of the State and local public entities with respect to measures on energy supply and demand and by prescribing matters that form the basis of measures on energy supply and demand, thereby contributing to the preservation of the local and global environment and to the sustainable development of the Japanese and global economy and society.
Article 2: Securing of stable supply	Measures shall be taken with the basic aim of diversifying energy supply sources, increasing energy self-sufficiency and achieving stability in the energy sector by undertaking such measures as reducing excessive dependence on specific geographic regions for the import of primary energy sources such as oil, promoting the development of energy resources […], providing for energy transportation systems, promoting the stockpiling of energy and energy use efficiency, etc. and implementing appropriate crisis management concerning energy.
Article 3: Environmental suitability	Measures shall be promoted to realize […] the prevention of global warming and the preservation of the local environment, as well as to contribute to the formation of a recycling society by improving energy consumption efficiency, by such measures as promoting the conversion to non-fossil-fuel energy use […] and the efficient use of fossil fuels.
Article 4: Utilization of market mechanisms	Economic structural reforms concerning energy supply and demand […] shall be promoted in a manner such that business operators can fully demonstrate their initiative and such that creativity and the interests of energy consumers are sufficiently secured, while giving due consideration to the policy objectives prescribed in the preceding two Articles.
Article 5: Responsibilities of the State	The State shall be responsible for comprehensively formulating and implementing measures on energy supply and demand in conformance with the basic policy on measures on energy supply and demand prescribed in Article 2 to the preceding Article inclusive (hereinafter referred to as the "Basic Policy").
Article 7: Responsibilities of business operators	When conducting their business activities, business operators shall be responsible for endeavoring to use energy efficiently and to use energy in a manner that gives consideration to stable supply of energy and preservation of the local and global environment, by demonstrating their initiative and creativity, and for cooperating with the measures […] implemented by the State and local public entities.
Article 12: Basic Energy Plan	The government shall formulate a basic plan on energy supply and demand (hereinafter referred to as the "Basic Energy Plan") […]. The Basic Energy Plan shall prescribe the following matters: • Basic policy on measures on energy supply and demand • Measures that should be taken in relation to energy supply and demand on a long-term, comprehensive and systematic basis • Technologies related to energy where intensive measures should be taken for their research and development in order to promote measures on energy supply and demand on a long-term, comprehensive and systematic basis, and measures that should be taken in connection with such technologies • In addition to what are listed in the preceding three items, any matters necessary for promoting measures on energy supply and demand on a long-term, comprehensive and systematic basis The government shall review the Basic Energy Plan at least once every three years by taking into consideration the changes in the situation concerning energy and based on an evaluation of the effects of measures concerning energy, and if it finds it necessary, make changes to the plan.

Source: Basic Act on Energy Policy (June 14, 2002)

The act also requires the establishment of a Basic Energy Plan by the government that provides for "basic policy on measures on energy supply and demand," "measures that should be taken in relation to energy supply and demand on a long-term, comprehensive, and systematic basis," and identifies "technologies related to energy where intensive measures should be taken for their research and development" required to implement these measures. The government is charged with reviewing this plan at least every three years and amending it as necessary in light of changes in the energy environment.

2. Basic Energy Plan

(1) Evolution of the Basic Energy Plan

The first Basic Energy Plan was formulated pursuant to the Basic Act on Energy Policy in October 2003. This was followed by a second plan in March 2007, and a third in June 2010.

The basic goal of the Basic Energy Plans is to achieve what are referred to as the "3Es"—Energy security, Economic efficiency, and Environmental acceptability—given Japan's lack of domestic energy resources.

Based on the goal of achieving the 3Es, the third Basic Energy Plan set out to raise Japan's energy self-sufficiency ratio and bolster access to energy resources. The plan further called for approximately 70% of the power generation mix to be accounted for by zero emission sources (53% nuclear power and 21% renewable energy) by the year 2030.

Following formulation of the third plan, however, the energy environment was transformed, both domestically and internationally, by the Great East Japan Earthquake and the accident at Tokyo EPCo's Fukushima Daiichi Nuclear Power Plant (Fukushima Daiichi Accident), which forced Japan to drastically rethink its energy policy.

The government responded by adopting a fourth Basic Energy Plan in April 2014. The overarching goal of this plan was to achieve the "3E+S"—the 3Es plus safety (S)—in order to reduce fossil fuel dependence and expand use of renewables in the years leading up to 2030. The plan adopted a safety-first policy of minimizing dependence on nuclear power as much as possible, while continuing to assign it an important role as a baseload power source.

(2) Fifth Basic Energy Plan

Under the Basic Act on Energy Policy the Basic Energy Plan is required to be reviewed at least once every three years. Accordingly, in August 2017 the Ministry of Economy, Trade and Industry (METI) began discussing revisions to the plan in earnest, and the fifth and most recent Basic Energy Plan was adopted in July 2018.

This fifth Basic Energy Plan presents two energy scenarios on the premise that Japan must begin immediately to conceptualize its longer-term energy options in readiness for the future depletion of fossil fuel resources. Like its predecessors, it maps the way forward for achieving the goals set in the Long-term Energy Supply and Demand Outlook for the years leading up to 2030 ("energy mix"; see (3) Long-term Energy Supply and Demand Outlook below). In addition, it also provides a 2050 energy scenario for achieving decarbonization by 2050, the target date for meeting the goals of the Paris Agreement.

Accordingly, the Basic Energy Plan adopts two key premises: firstly, that in the wake of the Fukushima Daiichi Accident Japan should pursue the adoption of renewable energy resources and minimize its dependence on nuclear power; and secondly, that in view of its lack of fossil fuel resources of its own, Japan should work constantly to develop and secure new energy technologies.

In line with these two premises, the fifth Basic Energy Plan calls for the maintenance and continued development of all kinds of energy technologies. To ensure that the 2030 energy mix is achieved, it calls for action to be further accelerated with a view to making maximum use of existing technologies. Supplementing this, the energy scenario for 2050 identifies a number of longer-term challenges that will need to be addressed to achieve energy transitions and decarbonization, and to make Japan a global leader in the field of energy technologies (Table 1.2).

(3) Long-term Energy Supply and Demand Outlook

The government considered what future form a realistic and balanced energy supply-demand structure should take given the principles laid down in the fourth Basic Energy Plan, and announced its Long-term Energy Supply and Demand Outlook in July 2015.

The energy mix targets set for 2030 in the Outlook were later inherited by the fifth Basic Energy Plan, which makes attainment of these targets a core goal.

Table 1.2 **The Fifth Basic Energy Plan (Outline)**

FIFTH BASIC ENERGY PLAN

We aim to contribute to further growth of the Japanese economy, improvement of the standard of living, and global development through energy supply that is stable, sustainable long term, and independent.

Following the 3E+S principles, realise an energy supply and demand structure that is stable, low-burden, and compatible with the environment.

3E+S		Sophisticated 3E+S
Safety	+	Safety innovation by technology/governance reform
Energy security	+	Raise technical self-sufficiency rate and ensure diversity of choice
Environment	+	Work towards decarbonization
Economic efficiency	+	Enhance domestic industrial competitiveness

Changing circumstances

1) Start of inter-technology competition for decarbonization
2) Geopolitical risk increased by technology changes
3) Intensified competition among nations and among firms

Towards 2030

—To reduce emission of greenhouse gases by 26%
—To achieve energy mix target
· Currently halfway to the target
· Deliberate promotion
· Realistic initiatives
· Intensify and enhance measures

<Primary measures>

- **Renewable energy**
  · Lay foundations to use as major power source
  · Cost reduction, overcome system constraints, secure flexibility of thermal power
- **Nuclear power**
  · Lower dependency on nuclear power generation to the extent possible
  · Restart of nuclear power plants and continuous improvement of safety
- **Fossil fuels**
  · Promote independent development of fossil fuels upstream, etc.
  · Effective use of high-efficiency thermal power generation
  · Enhance response to disaster risks, etc.
- **Energy efficiency**
  · Continued thorough energy efficiency
  · Integrated implementation of regulation of Act on Rationalizing Energy Use and support measures
- **Promotion of hydrogen/power storage/distributed energy**

Towards 2050

—Toward reducing GHGs by 80%
—Challenges towards energy transitions and decarbonisation
· Possibility and uncertainty
· Ambitious multiple track scenario
· Pursue every option
· Choose priorities by scientific review

<Primary directions>

- **Renewable energy**
  · Aim to use as major power source, economically independent and decarbonized
  · Start on hydrogen/power storage/digital technology development
- **Nuclear power**
  · One of the options for decarbonization
  · Pursuit of safe reactors, development of back end technologies
- **Fossil fuels**
  · Major power source during the transitional period. Enhance resource diplomacy
  · Shift to gas, phase out inefficient coal
  · Start hydrogen development for decarbonization
- **Heat & transportation, distributed energy**
  · Challenges for decarbonisation with hydrogen, power storage, etc.
  · Distributed energy systems and regional development (Combination of next generation renewables/power storage, EV, micro grid, etc.)

Draw up strategic plan ➡ All Japan's efforts (projects, international collaboration, financial dialogue, policy)

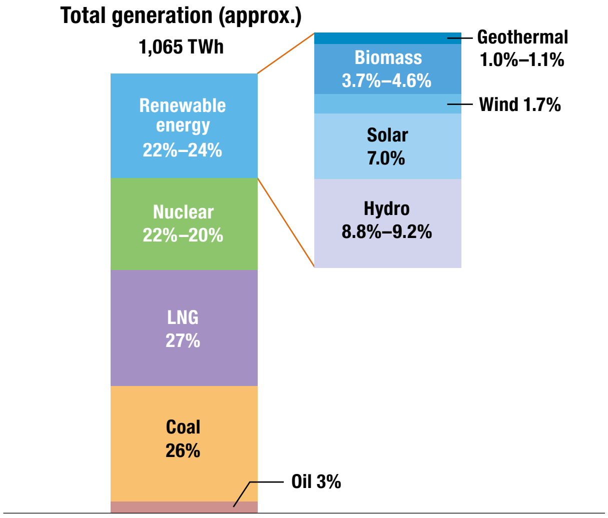
Source: Agency for Natural Resources and Energy, The Fifth Basic Energy Plan (Outline)

Taking as its overarching goal the development of a more diverse, multilayered supply-demand structure in order to ensure supply stability, the outlook seeks to improve Japan's energy self-sufficiency rate beyond the level prior to the Great East Japan Earthquake (approximately 25%).

More specifically, it expects thoroughgoing energy (electric power) conservation efforts to bring electricity demand in fiscal 2030 down to close to what it was in fiscal 2013.

Secondly, regarding renewable energy sources, the outlook forecasts nuclear power being replaced by

Figure 1.1 Power Generation Mix in Fiscal 2030



Source: METI, "Long-term Energy Supply and Demand Outlook 2015."

geothermal, hydro, and biomass power sources which are capable of stable output regardless of natural conditions, as well as by solar and wind power.

And thirdly, regarding thermal power generation, the outlook calls for a two-pronged strategy of reducing thermal power's environmental impact while raising the efficiency of coal and LNG (liquified natural gas) power generation. Nuclear power generation is projected to continue to occupy a key role as a baseload power source. At the same time, however, the outlook calls for reducing dependence on nuclear power as much as possible through a combination of thorough energy conservation, expanded use of renewables, and efficiency enhancements to thermal power plants. This will allow Japan to raise its energy self-sufficiency, ratio, keep down electricity costs, and reduce greenhouse gas emissions while maintaining safety as its overriding priority.

Power supply and demand in fiscal 2030 are therefore projected to be structured as shown in Figure 1.1. While nuclear power's share in the mix will fall from 25% before the Great East Japan Earthquake to around 20%-22%, renewables' share will increase from 10% to around 22%-24%.

3. Overview of Electricity System Reform

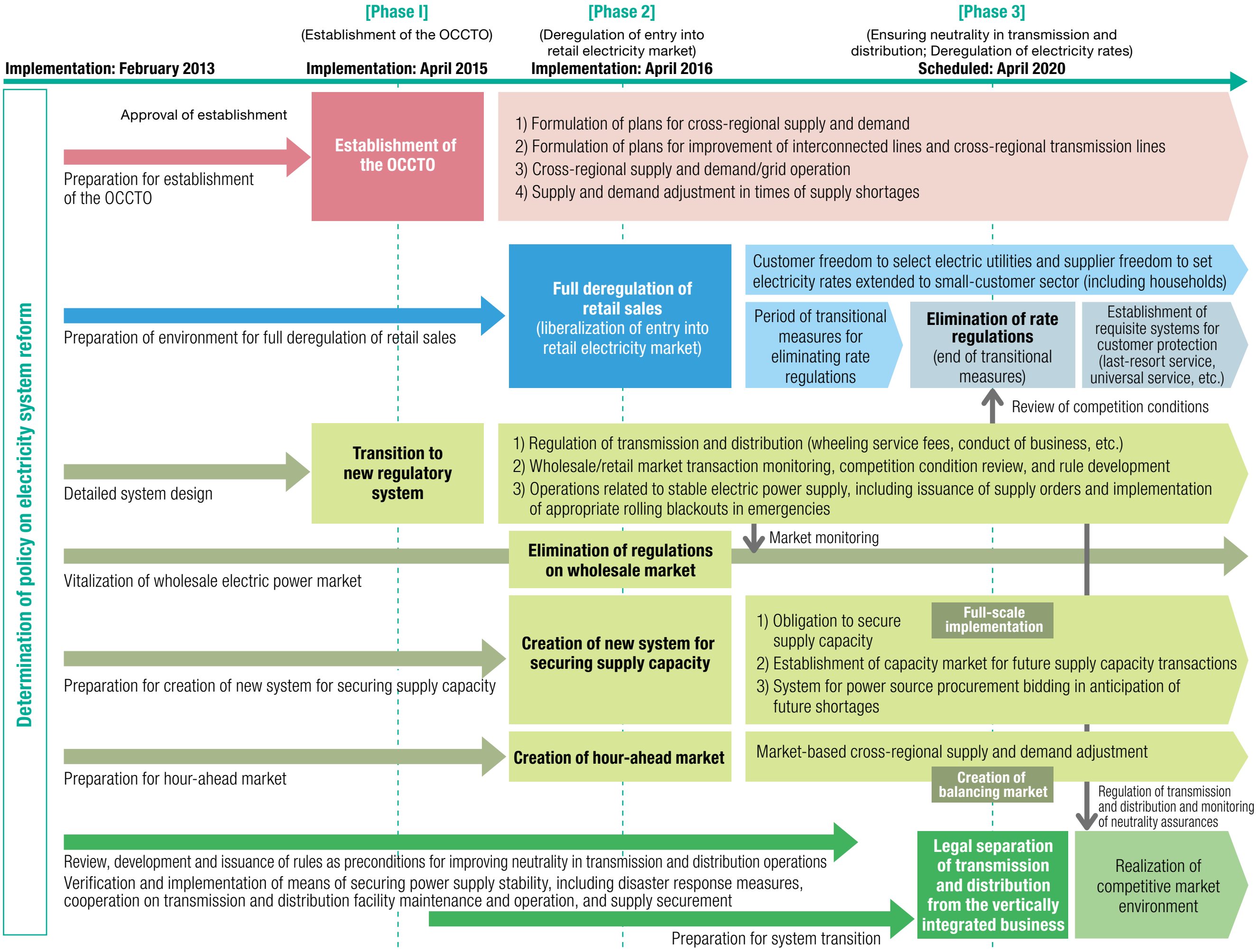
The Great East Japan Earthquake and the resultant Fukushima Daiichi Accident necessitated urgent action on many issues, including raising electricity rates, adjusting supply and demand and using a diversity of power sources in the face of a supply crunch. In January 2012 the Expert Committee on the Electricity Systems Reform was established under the Coordination Subcommittee of the Advisory Committee for Natural Resources and Energy to conduct an expert review of the future of Japan's electric power systems.

In its findings, published in February 2013 under the title "Report of the Expert Committee on Electricity Systems Reform," the Committee laid down three goals— (1) securing a stable supply of electricity, (2) suppressing electricity rate increases to the maximum extent possible and (3) expanding consumer choice and business opportunities for new market participants. It further identified three main ways of achieving these goals, namely, by (1) enhancing nationwide system operation, (2) fully deregulating the retail market and power generation, and (3) further ensuring neutrality in the transmission and distribution sectors through legal separation.

Following these recommendations, the Policy on Electricity System Reform describing the overall shape of reform was approved by the Cabinet in April 2013. This policy divided the reform process into three phases: in the first phase, establishment by 2015 of an Organization for Cross-regional Coordination of Transmission Operators (OCCTO) to act as a command center responsible for managing supply and demand spanning different service areas; in the second phase, full liberalization of entry into the retail electricity market by 2016; and in the third phase, legal separation of the transmission and distribution from the vertically integrated business, and elimination of retail rate regulation by 2018 through 2020.

The first phase was realized with the establishment of the OCCTO in April 2015, following the passage in November 2013 of the revised Electricity Business Act that provided for its establishment. In the second phase, a further revision to the act was passed in June 2014, the Electricity Market Surveillance Commission (now the Electricity and Gas Market Surveillance Commission) was established in September 2015 to strengthen monitoring of the deregulated electricity market, and electricity retailing and generation were fully deregulated in April 2016. An additional revision to the act passed on June 17, 2015, provided for the third phase of reforms, the legal separation of the transmission and distribution from the vertically integrated business. In this way, all the legislative changes necessary for the three-phase reform of the electric power system have been completed. The following preparations are now underway to pave the way for the legal separation of transmission and distribution from the vertically integrated business scheduled to be implemented in April 2020 (Figure 1.2).

Figure 1.2 Roadmap to Electricity System Reform



Source: Modified from the Report of the Expert Committee on Electricity Systems Reform (February 2013)

(1) System Design in Preparation for Separation of Transmission and Distribution from the Vertically Integrated Business in 2020

Preparations for the legal separation of transmission and distribution from the vertically integrated business in 2020 were considered by METI's Policy Subcommittee for Acceleration of Electricity System Reform, which published an interim report in February 2017.

The report noted the need to increase economic efficiency by fostering further competition in the electric power sector, while addressing a number of public interest-related issues that could not be resolved solely by relying on the market alone. These issues included ensuring safety, supply stability, environmental acceptability (including through the promotion of renewable energies), and fairness between consumers in the context of deregulation. It concluded that in order to solve these issues steps should be taken to make existing markets more liquid and to actualize and promote flows of new forms of value by creating completely new markets, such as a capacity market and a non-fossil value trading market.

Based on these conclusions, a number of new types of market are being considered, including (1) a baseload power market, (2) a capacity market, (3) a balancing market, and (4) a non-fossil value trading market. These new markets are considered in greater detail in 5. New Markets in Chapter II.

4. Nuclear Energy

(1) Position of Nuclear Power Generation in Government Policy

The accident at the Fukushima Daiichi Nuclear Power Plant caused huge damage and increased public concerns about nuclear power. Regional recovery and restoring public confidence are matters of the very highest priority to the government and the utilities.

At the same time, Japan's energy self-sufficiency ratio in 2016 according to IEA statistics was only around 8%, and fundamental structural weaknesses remain. The increase in imports of fossil fuel to power the thermal power plants used to replace nuclear power since the Fukushima Daiichi Accident has also imposed a greater financial burden on the public. Moreover, efforts have had to be made in recent years to reduce emissions of greenhouse gases to combat global warming.

Reflecting these circumstances, the fifth Basic Energy Plan approved by the Cabinet in July 2018 identifies nuclear power as an important baseload power source and sets a target for its share of the 2030 energy mix of 20%-22%. Nuclear power generation is also identified as "an option for decarbonization that is at the practical stage" in the long-term future energy scenario for 2050. If the above target is to be achieved, however, existing reactors will need to be restarted and operated for more than the 40 years set as the original operation period, and new and replacement capacity will need to be built. It is vital that there be substantive discussion of the future role of nuclear power.

(2) Action on Nuclear Safety Regulation

a. Reorganization of Nuclear Power Administration and Establishment of the Nuclear Regulation Authority

One of the lessons learned from the Fukushima Daiichi Accident was the negative impact of the compartmentalization of administration. Improvements to address this issue, including the separation of nuclear regulation and utilization policy, the unification of nuclear safety regulation work, and the revision of nuclear regulations, were therefore also investigated. The Act for Establishment of the Nuclear Regulation Authority was enacted in June 2012, and the Authority was established in September 2012 as an affiliated agency of the Ministry of the Environment. The Nuclear Regulatory Agency was further created to act as the authority's secretariat. Affairs concerning nuclear safety regulation that had previously fallen under the jurisdiction of multiple agencies were simultaneously centralized under the highly independent Nuclear Regulation Authority.

b. Adoption of New Regulatory Standards and Continuous Improvement of Nuclear Safety Regulation

Following the Fukushima Daiichi Accident, the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors ("Nuclear Reactor Regulation Act") was revised to incorporate a number of new provisions designed to strengthen nuclear safety regulation. These included:

1) Reinforcement of strategies for responding to severe accidents.
2) Introduction of a "backfitting" program requiring nuclear power facilities that have already received operating permits to comply with any new regulatory standards that are introduced incorporating the latest technological expertise.
3) Introduction of procedures for extending the period of operation of nuclear reactors (setting the period of operation at 40 years from the date of first commercial operation, but allowing a one-time extension to this term not to exceed 20 years where permitted by the Nuclear Regulation Authority).
4) Unification of regulation of nuclear reactor facilities used to generate electric power under the Nuclear Reactor Regulation Act.

The Japan Nuclear Safety Institute (JANSI) was launched in November 2012 to provide a private-sector framework for ensuring safety, and this has strengthened action to improve safety at individual power plants. It has been joined by the Atomic Energy Association (ATENA), established in July 2018 to strengthen arrangements to address common safety issues by utilities and manufacturers affecting the nuclear power industry as a whole. JANSI and ATENA will be working closely together to restore public confidence in nuclear power by continuing to promote independent action by the private sector to achieve high standards of safety.

(3) State of Nuclear Power Generation

a. Restarts and Decommissioning

The shutdown of Unit 3 of Hokkaido EPCo's Tomari Nuclear Power Plant for regular inspection in May 2012 took the last of Japan's fleet of nuclear reactors offline. However, the fourth Basic Energy Plan approved by the Cabinet in 2014 identified nuclear power as an important baseload power source, and permitted plants that had been found to comply with the new regulatory standards to be restarted.

A number of plants have been identified that operators hope to be able to bring back online by strengthening their defenses against natural disasters (such as earthquakes and tsunami), their preparedness for handling severe accidents, and their countermeasures against possible terrorism in order to bring them into compliance with new regulatory standards. As of October 2018, 15 nuclear reactors had been declared compliant and granted permission for their installation licenses to be amended in accordance with the new regulatory standards. The nine pressurized water reactors (PWR)

Table 1.3 **Compliance with New Regulatory Standards by Category**

Permitted to amend installation licenses in accordance with new regulatory standards (15 units)	Restarted	9 units
	Preparations in progress (Implementation of safety work, etc.)	6 units
Review of compliance with new regulatory standards in progress (including 2 units under construction)		12 units
Reactors for which applications under the new regulatory standards have not yet been filed (including 1 unit under construction)		10 units
Under consideration with a view to decommissioning (Fukushima Daini)		4 units
Total (including 3 units under construction)		41 units
To be decommissioned, decommissioning in progress, or operation terminated		19 units *2

Restarted units:

EPCos	Plant name	Restart date	
Kyushu EPCo	Sendai Unit 1	Aug. 11, 2015	
Kyushu EPCo	Sendai Unit 2	Oct. 15, 2015	
Kansai EPCo	Takahama Unit 3	Jan. 29, 2016	
Kansai EPCo	Takahama Unit 4	Feb. 26, 2016	
Shikoku EPCo	Ikata Unit 3	Aug. 12, 2016	*1
Kansai EPCo	Ohi Unit 3	Mar. 23, 2018	
Kyushu EPCo	Genkai Unit 3	Mar. 23, 2018	
Kansai EPCo	Ohi Unit 4	May 19, 2018	
Kyushu EPCo	Genkai Unit 4	June 16, 2018	

*1 Operation suspended by a temporary injunction granted by Hiroshima High Court in December 2017. The injunction was lifted by the court in September 2018, and commercial operation resumed in November 2018.
*2 Not including the three JPDR, Monju, and Fugen reactors.

shown in Table 1.3 are in or have reentered commercial service. Some boiling water reactors (BWR) have also now been confirmed compliant. In all, six reactors are being prepared to come back online pending local approval and the completion of safety improvement work.

On the other hand, at Fukushima Daiichi Nuclear Power Plant it was decided after the accident to decommission all of the plant's reactors, including the reactors that had not been damaged. The decision was also made to decommission several other reactors elsewhere in Japan in view of the cost of ensuring their compliance with the new regulatory standards. Additionally, in June 2018 Tokyo EPCo notified the local prefectural governor that it will consider decommissioning Units 1 to 4 at Fukushima Daini Nuclear Power Plant. The situation regarding restarts and decommissioning is summarized in the table below.

b. Extension of Period of Operation

The revision of the Nuclear Reactor Regulation Act in 2012 set the period of operation of nuclear reactors at 40 years from the time of entry into operation. However, this revision also introduced procedures for allowing a one-time extension of this period for up to 20 years from the time of expiration of the original period if approved by the Nuclear Regulation Authority. As of the end of November 2018, extensions had been approved for three PWR reactors operated by Kansai EPCo—Units 1 and 2 at the Takahama Nuclear Power Plant and Unit 3 at the Mihama Nuclear Power Plant, and work is now underway to implement safety measures to meet the conditions mandated for the extension of operation. In addition, an extension for Japan Atomic Power Company's Tokai No.2 Nuclear Power Plant was approved in November 2018, making it the first BWR to secure approval, and implementation of safety measures is under way with a target completion date of 2021.

c. Local Government and Resident Responses to Restarting Reactors

In some areas, local governments and residents have responded to the restart of nearby reactors by applying to the courts for temporary injunctions to halt their operation or by directly requesting utilities to shut them down. In the case of Units 3 and 4 at Kansai EPCo's Takahama Nuclear Power Plant, Osaka High Court lifted the temporary injunction prohibiting their restart in March 2017 and they are now back in operation. Operation of Unit 3 at Shikoku EPCo's Ikata Nuclear Power Plant had been suspended under a temporary injunction ordered by Hiroshima High Court in December 2017, but the injunction was lifted by the court in September 2018 and commercial operation resumed in November.

There have also been cases of local governments directly requesting utilities to shut down their reactors. The situation regarding restarts (including court rulings) has thus varied from region to region. Utilities have responded not only by working to meet the new regulatory standards, but also by actively disclosing information and explaining their positions more carefully to local governments and residents.

(4) The Nuclear Fuel Cycle

a. Basic Government Policy

As Japan is dependent on imports for the bulk of its energy resources, a basic policy of the government has been to establish a nuclear fuel cycle in order to reprocess the spent fuel generated by nuclear power generation and reuse the recovered plutonium and uranium as fuel. The Agreement for Cooperation between the Government of Japan and the Government of the United States of America concerning Peaceful Uses of Nuclear Energy that underpins this policy expired in July 2018, 30 years after it entered effect. It was automatically renewed without objection from either party.

In order to contribute to nuclear non-proliferation and to ensure that it pursues action with the understanding of the international community, Japan continues to adhere to the principle of not possessing any plutonium that does not have a use. It is therefore working to reduce its plutonium stockpile. Government policy is to pursue greater use of MOX fuel in thermal reactors, and to manage and use plutonium appropriately in accordance with the framework established by the 2016 Spent Nuclear Fuel Reprocessing Implementation Act.

b. Uranium Enrichment

As the uranium-235 used by nuclear power plants constitutes only about 0.7% of natural uranium, uranium must be enriched to a uranium-235 concentration of 3%-5% before use. Japan Nuclear Fuel Ltd. (JNFL), a private-sector company established to implement the nuclear fuel cycle on a commercial basis, built a commercial uranium enrichment plant in Rokkasho-mura, Aomori Prefecture, that entered operation in March 1992. JNFL subsequently applied for permission to switch to using a new, more cost-efficient type of centrifuge offering improved performance and to introduce other changes in compliance with the new regulatory standards. The Nuclear Regulation Authority granted permission for these operational changes in May 2017.

c. Spent Fuel Reprocessing

JNFL has been building a commercial reprocessing plant at Rokkasho-mura which is expected to be completed in the first half of 2021. In light also of the changing business environment faced by the nuclear power industry, including the deregulation of the electricity market, the Spent Nuclear Fuel Reprocessing Implementation Act was enacted in May 2016 to ensure the steady implementation of reprocessing work. The Nuclear Reprocessing Organization of Japan was also established in October of that year to serve as the corporation authorized to manage the funds necessary for reprocessing and to reliably perform reprocessing work and related activities.

Meanwhile, the Recyclable-Fuel Storage Company, jointly financed by Tokyo EPCo and Japan Atomic Power Company, is currently building a recyclable fuel storage center (the “Mutsu Interim Storage Facility”) in Mutsu, Aomori Prefecture, to provide a site for interim storage of spent fuel until it is transported to a reprocessing plant. This interim storage facility will enter operation with an initial storage capacity of 3,000 tons, which is scheduled to be increased ultimately to 5,000 tons.

d. Selection of Candidate Sites for Final Disposal of High-Level Radioactive Waste

In July 2017, METI published the Nationwide Map of Scientific Features for Geological Disposal as a preparatory step toward the final disposal of high-level radioactive waste generated from spent fuel. The government plans to narrow down the number of candidate sites based on this map.

e. Development of Fast Neutron Reactors

From the early days of nuclear power development on, work was pursued around the world to develop fast breeder reactors in order to establish a closed nuclear fuel cycle in readiness for the day when uranium resources grew scarce. As fears of uranium shortages waned, however, the world’s focus shifted increasingly toward the commercialization of light water reactors. In resource-poor Japan, however, construction of the Joyo experimental fast breeder reactor was followed by the Monju prototype fast breeder reactor in line with basic government policy.

Although Monju first successfully transmitted electricity in August 1995, a series of problems subsequently beset the facility. The government therefore convened a meeting of ministers concerned with nuclear power in December 2016 and officially decided to decommission Monju, and preparations for decommissioning have now begun. Over the longer term, questions concerning, for example, the revision of fast breeder reactor development targets and international cooperation are being considered primarily by a strategic working group set up under the Council on Fast Reactor Development.

(5) Decommissioning Work at Fukushima Daiichi Nuclear Power Plant

Recovery from the damage caused by the Fukushima Daiichi Accident and smoothly decommissioning the Fukushima Daiichi Nuclear Power Plant and dealing with the problem of contaminated water are all top priorities for the government and Tokyo EPCo. News on progress toward these goals can be viewed on Tokyo EPCo's website (http://www.tepco.co.jp/en/decommision/index-e.html).

a. Basic Policy on Decommissioning

In December 2011, nine months after the accident, Fukushima Daiichi Nuclear Power Plant reached a state in which the authorities could state that "release of radioactive materials is under control and radiation doses are being significantly held down." Coinciding with this, the government and Tokyo EPCo published a Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4 to guide decommissioning work and related measures at the plant.

This roadmap sets out details of the specific processes and work that will be performed, along with describing policy in areas such as the strengthening of arrangements extending from R&D to the actual decommissioning, the training of human resources, and international cooperation. A basic principle of the roadmap is that it is subject to continuous review in light of the actual situation at the plant, research findings, and other relevant factors, and revisions are being made to the roadmap as necessary.

b. Removal of Fuel from Spent Fuel Pools

When the accident occurred, it was decided in the interests of risk mitigation to remove the spent fuel then being stored in spent fuel storage pools from the pools at Units 1–4 and to store it appropriately in a shared pool at the site. The removal of spent fuel from the pool in Unit 4, where the most spent fuel was stored, was completed in December 2014. In Units 1, 2, and 3, rubble impeding the removal of fuel is still being removed, while steps are being taken to prevent the release of dust containing radioactive material and to monitor the concentration of radioactive material in the atmosphere. A domed roof has been completed over Unit 3, and work is underway to extract fuel.

c. Removal of Fuel Debris

Extensive "fuel debris," consisting of fuel and internal reactor structures that melted during the accident and then cooled and solidified, is believed to be present in Units 1, 2, and 3. Because of the extremely high levels of radiation in the reactor buildings, surveys of the interiors are presently being conducted using remote-controlled equipment.

d. Containment of Contaminated Water

Water is being injected continuously into the reactors to cool the fuel debris. More contaminated water is being generated by the day as a result of the cooling water mixing with groundwater that has penetrated the reactor buildings. In September 2013, the Nuclear Emergency Response Headquarters adopted the Basic Policy for the Contaminated Water Issue at TEPCO's Fukushima Daiichi Nuclear Power Station, and various countermeasures are now being pursued to address this problem in line with the three principles of (1) the removal of sources of contamination; (2) the isolation of water from contamination sources; and (3) the containment of contaminated water. An impermeable wall of frozen soil has also been created around the plant to isolate groundwater from the contamination source, with freezing of the entire circumference commencing in August 2017. Although these measures have reduced the problem, new emissions of contaminated water must still be stored in welded tanks following treatment by an advanced liquid processing system (ALPS). Land for tanks is growing scarce, and the government is leading a wide-ranging study examining social impacts as well as scientific safety in order to determine how best to dispose of water that has undergone ALPS treatment but still contains tritium that cannot be removed.

e. Improvement of the Working Environment

Decommissioning work over a prolonged period requires the employment of highly skilled and experienced human resources over the medium- to long-term. This makes it especially important to create safe and secure working conditions, and steps have been taken to minimize the radiation doses to which personnel are exposed. As a result of these efforts to improve the working environment, as of September 2018 the areas where full-face masks no longer have to be worn had been expanded to cover approximately 96% of the site, improving workability in these areas and allowing work to be performed in ordinary work clothes and disposable face masks.

f. Lifting of Evacuation Orders to Help Fukushima Recovery

The designation of areas where evacuation orders will soon be lifted and areas in which the residents are still not permitted to return to live has been reviewed as the effects of the accident have been contained and the risk of radiation exposure has declined. Remaining evacuation orders in areas where residents will not be able to return to their homes for a long time are also to be lifted subject to the following three conditions being met: (1) the annual effective dose is reliably found to not exceed 20 mSv; (2) infrastructure and living-related services have been largely restored and sufficient progress has been made on decontamination work (particularly in children's living environments); and (3) the prefecture, municipalities, and residents have been consulted. Evacuation orders are being lifted progressively, beginning with Tamura City in April 2014. Evacuation orders in all areas designated as areas where evacuation orders will soon be lifted and areas designated as areas in which the residents are not permitted to live (excepting those in the towns of Okuma and Futaba) were lifted in April 2017.

However, the evacuation orders for areas designated as areas where residents will not be able to return to their homes for a long time have yet to be lifted. Regarding these areas, the revised Act on Special Measures for the Reconstruction and Revitalization of Fukushima was enacted in May 2017 with the aim of enabling the evacuation orders for these areas to be lifted and human habitation to be permitted again within a period of approximately five years. In November 2017, a special zone for reconstruction and revitalization was designated in the town of Okuma and concrete plans put into effect to decontaminate the area and rebuild infrastructure in an integrated fashion so that evacuation orders could be lifted. The government is committed to ultimately lifting all evacuation orders, recovering from the damage, and restoring the region, no matter how long it may take.

5. Renewable Energy

(1) Targets and Prospects

Under the fourth Basic Energy Plan formulated in 2014, it was decided that the deployment of renewable energy sources would be accelerated as rapidly as possible for a three-year period beginning from 2013, and would continue to be promoted actively thereafter. The Long-term Energy Supply and Demand Outlook formulated in July 2015 set a target for renewable energy adoption

Table 1.4 Installed Capacity of Renewable Energy (As of End March 2018)

Type	Combined total by end June 2012	Capacity installed under FIT
Solar power (residential)	4,700 MW	5,410 MW
Solar power (non-residential)	900 MW	33,510 MW
Wind power	2,600 MW	970 MW
Small- and medium-scale hydropower	9,600 MW	310 MW
Biomass	2,300 MW	1,260 MW
Geothermal power	500 MW	20 MW
Total	20,600 MW	41,480 MW

Utility-scale solar power generation testing plant (Okinawa EPCo) to be achieved by fiscal 2030 of 22%-24% of total power generation, based on a policy of adopting renewable energies to the greatest extent possible in accordance with their respective individual characteristics while balancing this with containing the burden imposed on customers.

The fifth Basic Energy Plan adopted in July 2018, while still proposing that renewables be developed into a core energy source, calls for a review of the present feed-in tariff (FIT) scheme (see details below) to reduce the cost of renewables to the public.

(2) Legislation to Expand Renewable Energy Use

The government passed the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities in August 2011. The Act was aimed at promoting the extensive deployment of renewable energy sources (including hydropower plants with a capacity of under 30 MW) by requiring the electric utilities to purchase all the electricity generated by renewable energy producers.[1] This Act led to implementation of the FIT scheme for renewable energy on July 1, 2012. This scheme accelerated capital investment in renewables, with installed capacity growing by 41,480 MW between the launch of the FIT system and the end of March 2018. Including pre-FIT capacity total installed renewables capacity, reached approximately 62,080 MW.

The electricity supply sources, purchase prices and

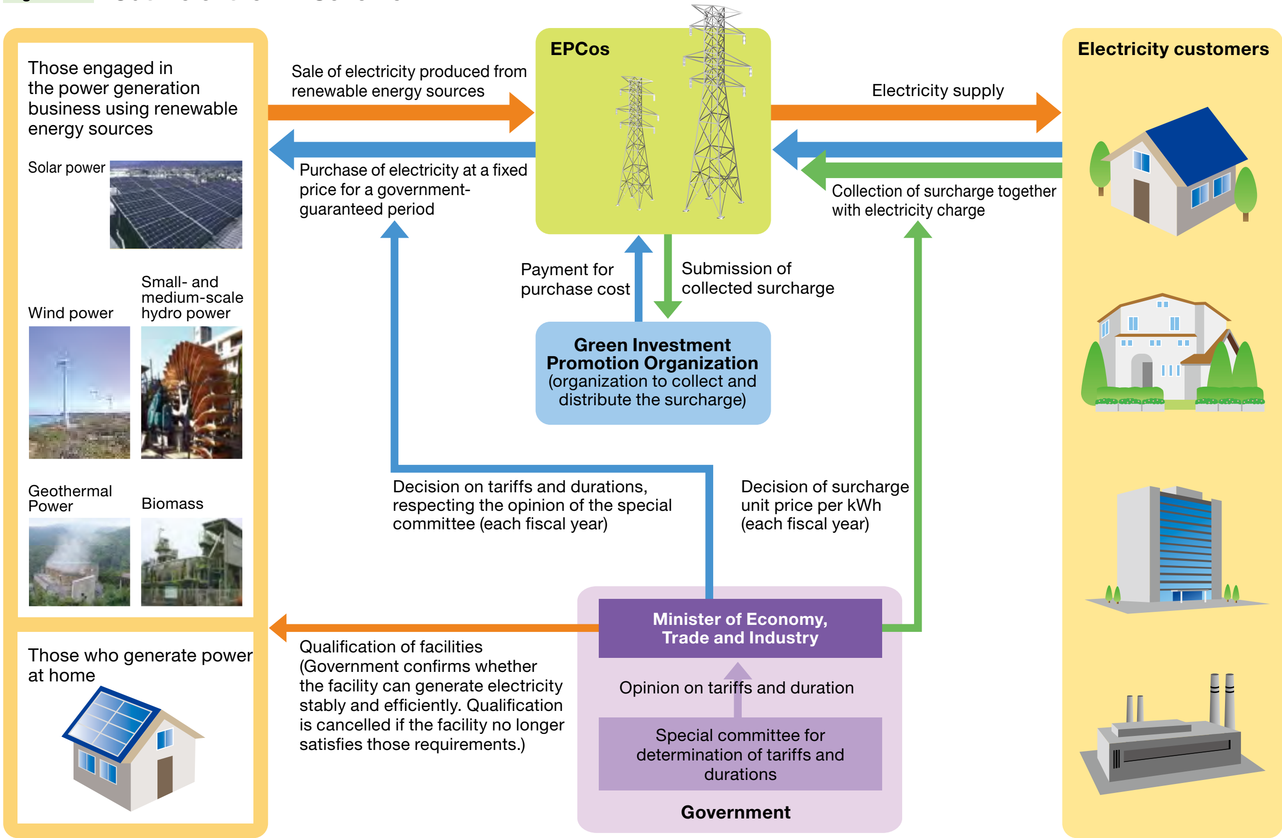
1. Electric utilities cannot purchase renewable electricity that they have produced themselves.

Table 1.5 **Purchase Price and Duration of the FIT Scheme**

Purchase category			Purchase price (Yen/kWh)				Duration (years)
			FY2017	FY2018	FY2019	FY2020	
Solar	Less than 10 kW	Output controller not required	28	26	24	—	10
		Output controller required*1	30	28	26	—	
		Output controller not required, dual generation	25		24	—	
		Output controller required*2, dual generation	27		26	—	
	10 kW–2,000 kW		21	18	—	—	20
	2,000 kW or above		Changed to procurement bidding system in FY2017				20
Onshore wind power	20 kW or above	Newly installed	21	20	19	18	20
	Less than 20 kW		55	20	19	18	
	All capacities	Replacement capacity	18	17	16		
Offshore wind power	Bottom-mounted offshore wind power		36	36	36	—	
	Floating offshore wind power		36	36	36		
Geothermal	Less than 15,000 kW		40				15
	15,000 kW or above		26				
Geothermal (replacement of all equipment)	Less than 15,000 kW		30				
	15,000 kW or above		20				
Geothermal (replacement of equipment excepting underground equipment)	Less than 15,000 kW		19				
	15,000 kW or above		12				
Hydro	Less than 200 kW		34				20
	200 kW–1,000 kW		29				
	1,000 kW–5,000 kW		27				
	5,000 kW–30,000 kW		20				
Hydro using existing conduits*2	Less than 200 kW		25				
	200 kW–1,000 kW		21				
	1,000 kW–5,000 kW		15				
	5,000 kW–30,000 kW		12				
Biomass	Methane fermentation gasification (biomass-derived)		39				20
	Woody biomass (thinnings, etc.) and agricultural crop residue	Less than 2,000 kW	40				
		2,000 kW or above	32				
	Construction material waste	All capacities	13				
	General waste and other biomass	All capacities	17				

*1 Output controllers are required in districts of Hokkaido, Tohoku, Hokuriku, Chugoku, Kyushu, and Okinawa EPCos.
*2 Upgrades to electrical facilities and penstocks utilizing existing conduits.
Source: Agency for Natural Resources and Energy, "2018 Guidebook on the Feed-in Tariff Scheme for Renewable Energy"

Figure 1.3 **Outline of the FIT Scheme**



Source: Website of the Agency for Natural Resources and Energy

purchase periods covered by the FIT scheme for each fiscal year are to be determined by the minister of METI. The purchase prices and periods for fiscal 2018 are as shown in Table 1.5. The system for determining the purchase price of electricity from wind, geothermal, biomass, and small and medium-sized hydro power generation, the introduction of which can take an extended time, was changed by amendments to the Act in February 2016 to a system in which prices for multiple-year periods are determined en bloc. In addition, the system for determining the purchase price for purchases of electricity generated by large-scale solar facilities (2 MW and above) was changed effective April 1, 2017, to one based on bidding in order to hold down purchasing costs.

Under the FIT scheme, the electric utilities are permitted to pass on their costs for the purchase of electricity generated by renewable energy sources to their customers in the form of a surcharge calculated in proportion to the customers' usage volume. The surcharge for fiscal 2018 is 2.90 yen per kWh (2.3734 trillion yen for Japan as a whole), or 9,048 yen per year for the standard model household. Under this system, electric utilities collect the surcharge from customers and transfer the funds to a cost-bearing adjustment organization called the Green Investment Promotion Organization, which refunds their purchase costs to them in due course.

The scheme also contains a provision that reduces the surcharge for customers who use extremely high volumes of electricity and who satisfy certain conditions.

Regarding purchases of electricity from solar power plants with a capacity of 2 MW or more that were transferred to the procurement bidding system from fiscal 2017, two tenders have been held. The first tender, announced in November 2017 resulted in nine successful bids (with a combined output of 141 MW) for a tendered capacity of 500 MW. The successful tender prices ranged between 17.20 and 21.00 yen per kWh. The second tender announced in September 2018 received 19 proposals (with a combined output of 196 MW) for screening to participate in the tender for a tendered capacity of 250 MW. Ultimately, however, none of the proposals came in below the supply price ceiling (15.50 yen per kWh), and there were no successful bidders.

(3) FIT Issues and Output Control

Notwithstanding the increase in investment in renewable energies and growth in FIT-approved capacity since 2012, many projects, particularly solar power projects, remain unfinished despite having already been approved under the FIT scheme. Most of these were approved between 2012 and 2014 just following the launch of the FIT scheme when purchase prices were high, and the government is considering revising the purchase prices applied to these projects. Meanwhile, the rapid growth in the installation of renewables has made it necessary to impose output controls. While the solar power connection limit in Kyushu EPCo's electricity service area is 8,170 MW, connected solar capacity had already reached 8,070 MW by the end of August 2018. Despite restricting output from thermal power plants, using interconnections, and employing excess power to pump up water for pumped storage, output controls requiring the suspension of operations by solar and wind power operators had to be imposed on mainland FIT operators for the first time in October 2018. Looking ahead, it is likely that output will have to be controlled during periods of low electricity demand in the future, such as during public holidays in the spring and autumn.

Under the surplus solar power purchasing system launched in November 2009 prior to the FIT scheme, power was purchased for a period of 10 years from solar power plants with a capacity of less than 500 kW. This period will end in November 2019, creating a problem that has been dubbed the "Year 2019 Problem." The plants affected are estimated to reach a capacity of about 6,700 MW in total by 2023, and many former general electric utilities and new market participants have indicated their intention to make purchases in the context of the government's adoption of a stance that favors (1) self-consumption of solar power and (2) reciprocal sale of surplus electricity.

6. Global Warming Countermeasures

(1) International Frameworks and Japanese Government Initiatives

a. Greenhouse Gas Emission Reduction Targets from 2020

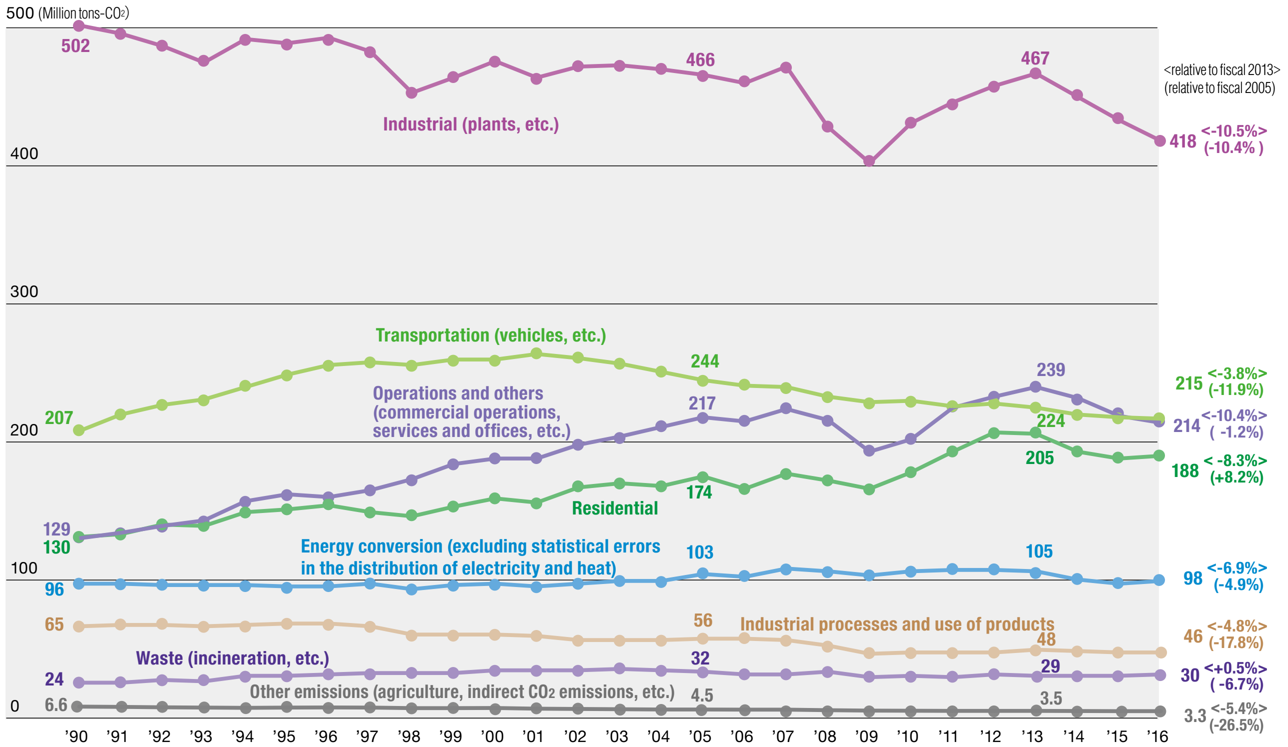
In July 2015 the Japanese government set an Intended Nationally Determined Contribution (INDC) target of reducing greenhouse gas (GHG) emissions by 26.0% in fiscal 2030 compared with fiscal 2013 levels (25.4% compared with fiscal 2005 levels), which was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat. The reduction target was set taking into consideration technical constraints, cost factors, and other issues imposed by the need for consistency with Japan's energy mix.

At the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) held in December 2015, 195 countries and regions adopted the Paris Agreement, which is focused on GHG emission reductions from 2020 onward. The Paris Agreement sets forth long-term shared global targets including keeping the average global temperature increase well below 2°C above pre-industrial revolution levels and balancing anthropogenic GHG emission and absorption by the second half of this century. Unlike the Kyoto Protocol, which required only advanced nations to reduce their emissions, the Paris Agreement requires all signatory countries to submit emissions reduction targets as well as the domestic policies to be employed to achieve those targets, and the extent to which those targets have been attained is to be evaluated every five years.

Table 1.6 Government Action on GHG Reduction Targets

Date	Trend
December 1997	Kyoto Protocol adopted at COP3. Japan's GHG reduction target set at 6% below 1990 levels.
October 1998	Act on Promotion of Global Warming Countermeasures instituted in response to adoption of the Kyoto Protocol.
April 2005	Kyoto Protocol Target Achievement Plan outlining the measures necessary to attain Japan's 6% GHG reduction target approved at a meeting of the Cabinet.
January 2010	The Japanese government responds to the Copenhagen Accord (COP15) by submitting a GHG reduction target for 2020 of 25% below Japan's 1990 levels to the Secretariat of the United Nations Framework Convention on Climate Change, premised on establishment of a fair and effective international framework and agreement to ambitious targets by all major countries.
November 2011	At COP17, Japan declares that it will not participate in the second commitment period under the Kyoto Protocol.
November 2013	At COP19, Japan announces a target of achieving a 3.8% reduction relative to fiscal 2005 by 2020.
July 2015	As Japan's INDC toward post-2020 GHG emission reductions under COP19, the government submits to the UNFCCC Secretariat a target of reducing emissions by 26% below fiscal 2013 levels (a 25.4% reduction relative to fiscal 2005 levels).
May 2016	The Plan for Global Warming Countermeasures approved at a Cabinet meeting in response to the conclusion of the Paris Agreement.

Figure 1.4 Changes in CO_2 Emissions by Sector



Note 1: Emissions by sector are calculated by distributing the emissions that accompany power generation and thermal generation among the respective final consumption sectors.
Note 2: Percentages in parentheses indicate change in emissions in each sector in fiscal 2013 relative to fiscal 2005.

Source: "Regarding Greenhouse Gas Emissions in Fiscal 2016 (Final Values)"

The Plan for Global Warming Countermeasures was approved at a Cabinet meeting in May 2016 that sets out how the mid-term targets outlined in the INDC submitted by Japan in 2015 will be achieved. What is important here is to steadily implement the countermeasures outlined in the INDC on the way to achieving the mid-term targets, and the government is looking to utilize a diverse range of policy tools including voluntary measures, regulatory measures and economic measures, exploiting their respective characteristics in an effective manner. The intention is to encourage the adoption of highly energy-efficient equipment in the industrial, commercial, and residential sectors while maximizing the introduction of renewable energies, improving thermal power plant efficiency, and utilizing nuclear power plants that have been confirmed to be safe in the energy conversion sector.

Table 1.6 shows the government's initiatives relating to GHG reduction targets since adoption of the Kyoto Protocol in 1997.

b. Joint Crediting Mechanism

The Japanese government employs the Joint Crediting Mechanism (JCM) to effectively address climate change, based on the belief that achieving "low-carbon growth" globally depends on both developed and developing countries alike making adequate use of technologies, markets, and funds.

The JCM allows contributions to GHG emission reductions and carbon capture achieved in partner countries through transferals of Japanese low-carbon technologies and products to be counted as part of Japan's contribution.

The Japanese government has consulted with developing countries concerning the JCM since 2011. It has signed bilateral documents with 17 countries, the latest being with the Philippines in January 2017.

JCM projects underway in the electricity sector include a 40 MW hydro power plant in Lào Cai Province, Vietnam, and project development studies in Vietnam, Thailand, and elsewhere regarding installation of micro hydro power plants at water treatment plants.

(2) GHG Emissions and Voluntary Efforts by the Private Sector

a. GHG Emissions in Japan

In fiscal 2016, Japan's GHG emissions measured 1,307 million tons (CO_2 equivalent), a 7.3% decrease from fiscal 2013 and a 5.2% decrease from fiscal 2005.

CO_2 emissions in fiscal 2016 totaled 1,206 million tons, accounting for 92.3% of all GHG emissions. These

Table 1.7 **Actual CO_2 Emissions by the Electric Power Industry**

Fiscal Year	2008	2009	2010	2011	2012	2008-2012 (Average)	2013	2014	2014 (Reference values)	2015	2016	2017 (Preliminary figures)
Electricity consumed (TWh)*1	889	859	906	860	852	–	849	823	–	–	–	–
CO_2 emission volume (Million tons-CO_2)	332	301	317	409	415	–	484	456	469	441	430	411
End-use CO_2 emission intensity*2 (kg-CO_2/kWh)	0.373 [0.444]	0.351 [0.412]	0.350 [0.413]	0.476 [0.510]	0.487 [0.571]	0.406 [0.469]	0.570 [0.570]	0.554 [0.556]	0.552	0.531	0.516	0.496

*1 Electricity consumed includes electricity purchased from joint thermal power generators, IPPs, self-generators, etc., connected to the grid.
*2 Values in brackets do not reflect adjustments made for Kyoto Mechanism credits, the surplus solar power purchasing system, and the FIT scheme for renewable energy.
Source: FEPC, "Environmental Action Plan by the Japanese Electric Utility Industry" (September 2015)
Source for fiscal 2014 (reference values), fiscal 2015, 2016 and 2017 (preliminary figures): The website of the Electric Power Council for a Low Carbon Society (ELCS)

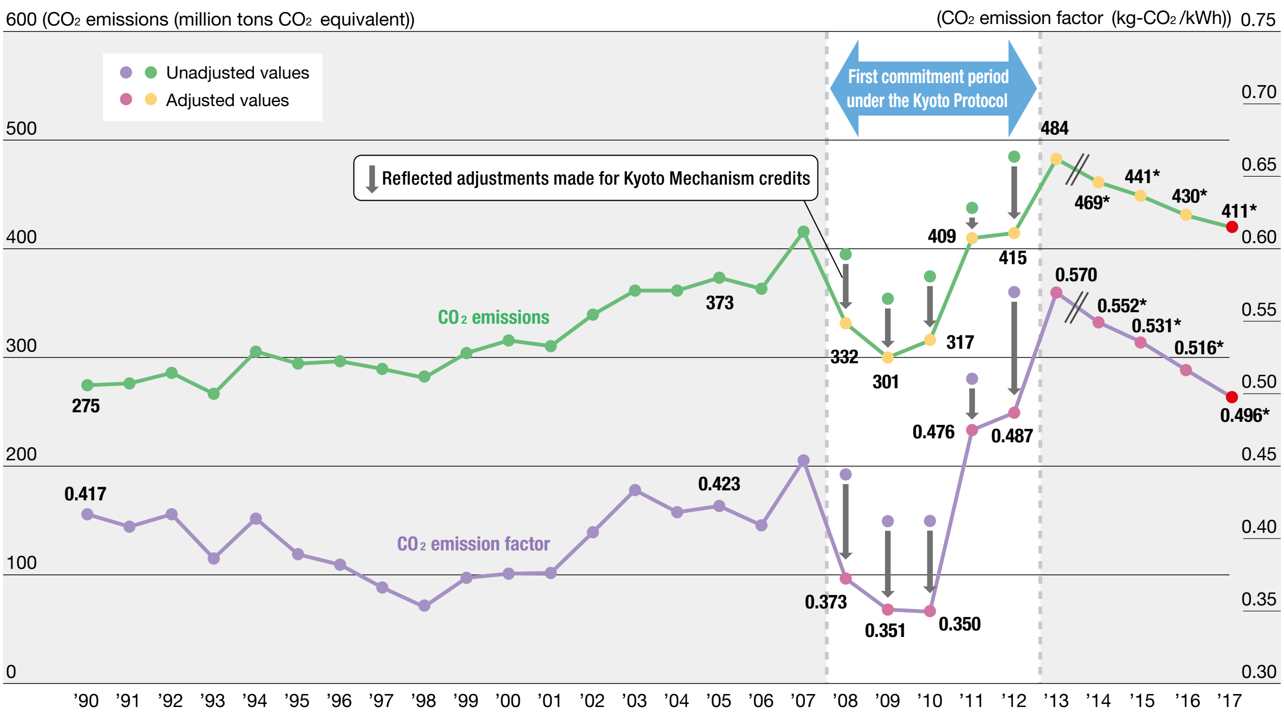
CO_2 emissions were 8.3% lower than in fiscal 2013 and 6.5% lower than in fiscal 2005. Factors behind the decrease in CO_2 emissions from the previous fiscal year included both lower energy consumption due in particular to energy conservation and a proportional increase in the use of non-fossil fuels.

Emissions fell in all sectors between fiscal 2013 and fiscal 2016, declining by 10.5%, 10.4%, and 8.3% respectively in industry, the commercial sector, and the residential sector. This was due largely to lower energy consumption resulting from energy conservation in all sectors and to improvements in the CO_2 emission intensity for electricity.

b. Voluntary Efforts by the Private Sector

In order to better contribute to global CO_2 emission reductions over the long-term, the Japan Business Federation (Keidanren) issued the Commitment to a Low Carbon Society (Phase I) in 2013, followed in 2015 by the Commitment to a Low Carbon Society (Phase II) laying down commitments up to 2030 in order to further contribute to action on climate change. As of April

Figure 1.5 **CO_2 Emissions of the Electric Power Industry**



Data from 1990 to 2013 is cited from Source 1, and data after 2014 from Source 2.
Source: 1. FEPC, "Environmental Action Plan by the Japanese Electric Utility Industry" (September 2014)
2. The Electric Power Council for Low Carbon Society

2017, 62 industries have set targets and taken actions for 2030 relating to emissions resulting from their business activities in Japan. Japanese industries are also working to strengthen their efforts relating to coordination between business entities, international contributions, and innovative technological development.

Commitment to a Low Carbon Society calls for participants to set targets and review progress themselves to ensure the effectiveness of their actions, and further commits the Japanese business community with its technological strengths to play a key role in the drive to halve global GHG emissions by 2050.

c. CO_2 Emission and Global Warming Countermeasures Implemented by the Electric Power Industry

Japan's electric utilities are participating in the Japan Business Federation's aforementioned Commitment to a Low Carbon Society and are promoting measures on both the supply and demand sides of the electric power sector. In July 2015 the utilities announced their own Commitment to a Low-Carbon Society in the Electricity Industry, which commits them to achieving a CO_2 emission factor in fiscal 2030 of approximately 0.37 kg-CO_2 /kWh (equivalent to a reduction of 35% from the fiscal 2013 level). The Electric Power Council for a Low Carbon Society (ELCS), which includes members of the Federation of Electric Power Companies of Japan (FEPC) as well as new entrants to the market, was established in February 2016 with the aim of moving forward with the attainment of these targets for all electric utilities as a whole.

According to data released by ELCS, CO_2 emissions in fiscal 2017 (preliminary figures) came to 411 million tons-CO_2 and the CO_2 emission factor was 0.496 kg-CO_2/kWh.

On the supply side, the utilities are working on a range of initiatives, including implementing thoroughgoing safety measures based on the lessons learned and knowledge gained from the Fukushima Daiichi Nuclear Power Plant accident, and feeding electricity derived from renewable energy sources into the grid based on the FIT scheme for renewable energy.

On the demand side, they are actively promoting energy conservation and carbon emission reduction, and pursuing the widespread installation of smart meters to create an environment conducive to more efficient electricity use.

The utilities are also actively pursuing research and development, working to develop a range of promising technologies, including clean coal technologies, CO_2 capture and storage technologies, next-generation power transmission and distribution technologies, and ultra-high-efficiency heat pumps.

Table 1.7 shows actual CO_2 emissions by the electric power industry, while Figure 1.5 tracks CO_2 emission trends in the industry.

Sarulla Geothermal Power Plant (Sarulla Operations Ltd., a joint venture of Kyushu EPCo, ITOCHU Corporation, INPEX CORPORATION, PT Medco Power Indonesia and Ormat Technologies, Inc.)

The Sarulla Project is one of the largest geothermal IPP power projects in the world (330 MW). The plant's first unit entered operation in March 2017, followed by the second in October 2017 and the third in May 2018. All units are in commercial operation.

II. ELECTRICITY SUPPLY SYSTEM

1. History of Japan's Electric Power Industry

(1) Transition from the Early Period to the Current System

Japan's electric power industry came into being with the commencement of operations by the Tokyo Electric Light Company in 1886. Numerous electric power companies were subsequently established around Japan to serve growing demand for electricity driven by increasing industrialization and the economic boom during World War I. By the early 1930s their number exceeded 800. However, the fierce competition engendered mainly in urban areas by the prolonged depression led to a series of mergers and acquisitions. As a result, Japan's electric power industry ultimately coalesced around five main utilities (Tokyo Electric Light Company, Toho EPCo, Daido EPCo, Ujigawa EPCo and Nippon EPCo).

As Japan headed into World War II, the electric power companies came under the control of the government. After the Japan Electric Generation and Transmission Company was established in 1939, electricity generation and transmission came under centralized control, and the electricity distribution business was consolidated into nine separate blocks. Following World War II, the Japan Electric Generation and Transmission Company was dissolved in accordance with the Ordinance for the Reorganization of the Electricity Utilities Industry (enacted in 1950) and the company's facilities were transferred to electricity distribution companies in nine different regions around the country. The nine electricity distribution companies to which the facilities were transferred subsequently became privately owned electricity utilities with regional monopolies based on an integrated system of electricity generation and transmission (i.e., one in which each company handled everything from power generation to transmission and distribution itself). This regime was confirmed by the Electricity Business Act (enacted in 1964). The number of these electric power utilities increased to 10 with the establishment of Okinawa EPCo following the reversion of Okinawa to Japanese control in 1972.

Thus organized into a system of regional monopolies,

Table 2.1 Outline of Electric Supply System Reform

1st Set of Reforms (1995)	1) Introduction of a power procurement bidding system for general electric utilities. Permission for independent power producers (IPPs) to enter the wholesale business (liberalization of wholesale supply) 2) Implementation of a system of "special electric utilities" authorized for retailing in designated service areas 3) Introduction of an incentive system to encourage general electric utilities to improve efficiency (introducing a yardstick system to assess their performance when they apply to raise electricity rates)
2nd Set of Reforms (2000)	1) Liberalization of retailing for extra high-voltage customers 2) Change from an approval system to a notification system for rate adjustments (e.g., reductions)
3rd Set of Reforms (2004)	1) Liberalization of retailing extended to high-voltage customers 2) Establishment of a neutral body (Organization to Support Electricity Transmission and Distribution) for providing rules and monitoring the transmission and distribution of general electric utilities. 3) Introduction of a code of conduct for general electric utilities in transmission and distribution (information ringfencing, prohibition of discriminatory treatment, etc.) 4) Development of nationwide wholesale markets
4th Set of Reforms (2008)	1) Activation of wholesale electricity exchange, and improvements in grid use competition conditions 2) Stable supply and environmental suitability (e.g., green energy trading)
Electricity System Reform (2012 to present)	1) Expansion of cross-regional grid operation (establishment of OCCTO) 2) Full liberalization of retail market entry 3) Legal separation of transmission and distribution from the vertically integrated business, and abolition of retail rate regulation

Note: Reforms were discussed or decided in the years indicated above, but not all were implemented that same year.

these utilities invested systematically in power supply facilities to meet growing demand for electricity to power Japan's rapid economic growth. As private enterprises, they simultaneously sought to deliver affordable, stable supplies of electricity while continuing to make management efforts to maximize shareholder equity. As a result, they contributed significantly to Japan's two decades of rapid growth from the 1950s on by providing high-quality, affordable electricity with a minimum of outages. Although electricity rate hikes were introduced in the wake of the global oil crises of the 1970s, rates were lowered several times between the 1980s and 2000s and the supply of electricity continued to underpin the development of the national economy.

(2) Increasing Liberalization of the Electricity Market

The trend toward deregulation in Japan's electric power industry continued with the liberalization of wholesale supply in 1995, followed by retail supply liberalization for customers receiving extra high-voltage (20 kV or above) in 2000. The scope of deregulation was expanded further in stages thereafter: to high-voltage (6 kV) customers with contracted demand of 500 kW or above, in principle, in April 2004, and to all customers in the high-voltage category (those with contracted demand of 50 kW or above) in April 2005.

METI began examining the pros and cons of expanding the scope of retail liberalization to include the household sector in April 2007. It concluded that it would reexamine the advisability of expanding the scope of retail electricity market liberalization after five years. Power shortages and other issues caused by the 2011 Great East Japan Earthquake, however, prompted renewed discussion of the ideal configuration of the nation's electric power system and its reform. Based on this discussion, a new entity called the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) was established in April 2015 with the aim of enhancing the capacity to adjust supply and demand nationwide in both normal and emergency situations. In addition, full liberalization of the retail market including consumers utilizing less than 50 kW was implemented beginning from April 2016. A new system was further introduced that separated the market into generation, transmission and distribution, and retail sectors, and issued licenses to business operators in each sector. Legal separation of the electricity network sector is scheduled to be implemented in April 2020.

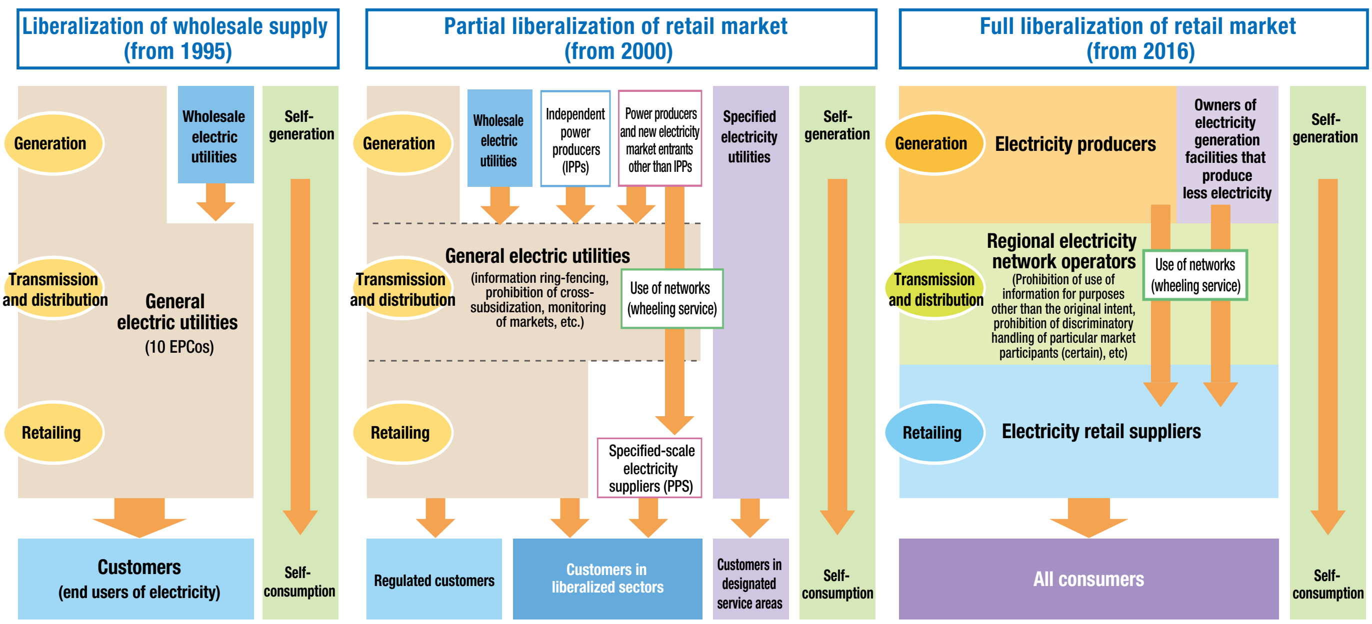
2. Current Electric Power Industry System

(1) Regulatory Organizations

a. Agency for Natural Resources and Energy

The Agency for Natural Resources and Energy is an

Figure 2.1 **History of the Electricity Supply Structure**



Source: Agency for Natural Resources and Energy external organ of METI, which is responsible for policies regarding energy conservation, new energies, and securing a stable, efficient supply of energy from oil, electricity, gas, and other sources. With regard to the electric power industry, the agency is responsible for developing the electricity market and electricity sources, adjusting electricity market supply and demand, and planning, devising, and promoting policies relating to nuclear power, renewables and "smart communities."

b. Electricity and Gas Market Surveillance Commission

The Electricity and Gas Market Surveillance Commission was established on September 1, 2015, as an entity under the direct control of the Minister of Economy, Trade and Industry in advance of the liberalization of electricity, gas, and heating supply, with the aim of further strengthening monitoring of the energy markets and related functions and encouraging sound competition. The Commission's powers include the ability to conduct on-site inspections of utilities, recommend business improvements, act as an arbitrator/mediator, approve wheeling service charges, and carry out reviews of retailer registrations. It also has the power to monitor the fairness of transactions and regulate business conduct to safeguard the neutrality of the electricity and gas network sectors. The commission's chairman and four commissioners are appointed by the Minister of Economy, Trade and Industry from among individuals who possess specialist knowledge and experience regarding law, economics, finance, or engineering and are able to make fair and neutral judgments in the performance of their duties.

(2) Organization for Cross-regional Coordination of Transmission Operators (OCCTO)

OCCTO was established in April 2015 as the first stage in the three-stage reform of the electricity industry. Its objectives are to promote development of the transmission and distribution networks required to make cross-regional use of generating sources, and to strengthen the industry's capacity to adjust supply and demand nationwide in both normal and emergency situations.

Its main functions include:

1) To coordinate supply-demand plans and grid plans, boost the transmission infrastructure (including the capacity of frequency converters and interregional interconnections), and facilitate nationwide grid operation spanning different areas.
2) To coordinate cross-regional supply-demand balancing and frequency adjustment by the transmission operators in each area during normal situations.
3) To adjust supply and demand by instructing that output be increased and power shared in case of power shortages due to a disaster or other emergency.
4) To neutrally perform functions relating to the acceptance of connections from new power sources and disclosure of grid data.

(3) Main Classifications of Electric Utility Market Operators

With the shift to a license-based system in April 2016, a comprehensive review was carried out of the classification of Japan's electric utilities. Hitherto, utilities had been divided into the following five categories: general electric utilities, wholesale electric utilities, wholesale suppliers, specified electricity utilities, and specified-scale electricity suppliers (PPSs). Under the new license-based system, the former general electric utilities are now classified into three separate categories: electricity producers, regional electricity network operators, and electricity retail suppliers. With the further addition of independent electricity network operators and site-specific electricity network operators, participants have now been classified into five categories in all. Electric utilities are primarily formed with private capital.

3. Wholesale Electricity Market

The Japan Electric Power Exchange (JEPX) was established in November 2003 to provide a privately operated, voluntary wholesale exchange designed to stimulate transactions on the exchange contributing to the strengthening of utilities' risk management capabilities by, for example, offering enhanced instruments for selling and sourcing electricity and encouraging the formation of index prices to assist assessments of investment risk. JEPX commenced trading in April 2005 and was designated a wholesale electricity market under the provisions of the Electricity Business Act in April 2016.

The principal market participants are the electricity producers involved in wholesale power transactions and electricity retail suppliers. However, other players, such as regional electricity network operators that accept electricity generated by feed-in tariff plants, are also involved as "special trading members" in order to facilitate the sale and purchase of "non-fossil value," as described in a later section. Businesses such as demand response aggregators that enter into negawatt trading contracts with regional electricity network operators have also been permitted to participate in the market since March 2017. As of September 2018, 145 companies were trading members.

JEPX currently provides a marketplace for the following electricity transactions:

1) Spot market: Trading in 30-minute increments of electricity for next-day delivery.
2) Forward market: Trading in electricity for delivery over the course of a specified future period. Products are created by packaging together specific periods and times, such as monthly 24-hour products or weekly daytime products.
3) Intra-day market: A market for correcting unexpected misalignments between supply and demand occurring between a spot market transaction and delivery (a minimum of one hour later).
4) Bulletin board trading market: JEPX mediates the trading of electricity and instruments such as Kyoto Mechanism credits under COP3 for prospective buyers and sellers. One example of a bulletin board trading market is the distributed and green electricity selling market launched as part of the electricity supply and demand measures implemented by the government in the summer of 2012. Non-members of JEPX can also sell electricity through this mechanism, which is designed for trading small volumes of surplus nonutility power and green power.

Power traded through the spot market on the exchange accounted for approximately 3% of the volume of electricity sold in fiscal 2016, and approximately 7% in fiscal 2017. As of April 2018, the volume of transactions had surged to account for 15%-20% of total demand.

4. Retail Electricity Market

The full liberalization of the retail market through the deregulation of Japan's low-voltage sector in April 2016 means that the approximately 8 trillion yen electricity market to which the former general electric utilities supplied electricity under a monopolistic arrangement has now been opened up to other participants. Following this change, sales turnover of operators in the retail electric power market (including the already liberalized high-voltage sector) reached to a total of 14 trillion yen as of June 2018.

Full liberalization has attracted a large number of operators to the retail electricity market. Entry to the retail market requires government approval, and 507 operators had been registered as electricity retail suppliers as of September 20, 2018. This wave of new entries has resulted in the emergence of a range of new options for customers, including electricity packaged with gas and other services, loyalty schemes, and the supply of CO_2-free electricity. To better protect consumers following liberalization, consumers will be able to continue to purchase electricity at the pre-liberalization rates (regulated rates) charged by their supplier prior to liberalization up until April 2020.

5. New Markets

In order to encourage further competition in the wholesale and retail markets as described above and achieve the goals underlying its sweeping reform of the electric power system, the Japanese government is considering the establishment of several new markets.

The intention is that the creation of these unconventional new markets will serve to actualize and render tradable new forms of value to accompany the enhanced fluidity of existing markets.

The main mechanisms under consideration are (1) a baseload power market, (2) a capacity market, (3) a balancing market, and (4) a non-fossil value trading market.

1) Baseload Power Market

New market entrants find it difficult to own or enter contracts to buy electricity from affordable baseload power sources such as coal, large-scale hydropower, and nuclear power plants. To surmount this difficulty, creation of a market dedicated to the trading of electricity produced by baseload power plants is now under consideration. Such a market will give existing electric power companies and new entrants equal access to electricity from baseload power plants. The expectation is that the resulting stimulation of the wholesale market will lead to increased competition in the retail market.

Transactions on the baseload power market are expected to commence in fiscal 2019, with deliveries of electricity to start in fiscal 2020.

2) Capacity Market

Although ideally power generation investments should be recoverable through market transactions, the predictability of the payback on investment in most power plants is likely to decline. If the adoption of renewables expands simultaneously, it is expected that the utilization of power generation capacity will decline, the selling price of electricity will fall, and revenues from selling electricity from all sources will come down.

Conversely, however, if investments in power generation capacity are not made at the appropriate time, there could be more situations in which the supply and demand balance becomes too tight, and electricity balancing capacity cannot be secured.

It has therefore been decided to introduce a capacity mechanism to ensure a greater degree of investment predictability. The creation of a capacity market to ensure the replacement of old power plants with new ones and the securing of actual (installed) supply capacity through market mechanisms is now under consideration.

The intent is to open the capacity market to transactions in fiscal 2020, and to have capacity contracts become effective from fiscal 2021.

3) Balancing Market

The tasks of controlling frequency and balancing supply and demand are performed by the regional electricity network operators in each area. With regard to balancing, it is important that operators secure the capacity required for practical purposes while avoiding giving preferential treatment to particular sources of electricity or creating too great a cost burden.

Japan's first auction for balancing supply and demand was held by regional electricity network operators at the end of 2016 for balancing supply and demand for fiscal 2017.

A balancing market for procuring and operating balancing supply and demand more efficiently on a cross-regional basis is now under consideration, with a view to launching the market during or after fiscal 2020.

4) Non-Fossil Value Trading Market

The wholesale electricity market described above makes no distinction between fossil fuel and non-fossil fuel power generation, and there are concerns that this omission could obscure the actual value of non-fossil power generation capacity. As it has also been observed that it is difficult for new entrants to buy electricity from non-fossil fuel sources, the creation of a market that brings non-fossil to the fore and enables the trading of non-fossil fuel value is also under consideration.

It has further been proposed that the cost of the environmental value of electricity derived from renewables purchased through the FIT scheme should not have to be borne by all customers, but instead should be borne primarily by those customers who desire that value. Ways of actualizing this value and enabling it to be bought and sold in the marketplace are being considered in order to achieve this goal.

As one step to help address these concerns, a non-fossil value trading market was established in the wholesale electricity market described above to isolate non-fossil fuel from the actual electricity produced and to certify it for trading.

The first auction of non-fossil certificates for FIT electricity was held on May 18, 2018. Certificates for approximately 5,160 MWh of electricity were bought by 26 companies at a contracted price of 1.3 yen per kWh.

Trading of non-fossil power sources other than those covered by the FIT scheme is scheduled to commence in fiscal 2019.

It is hoped that the establishment of this market will help Japan reach its global warming targets by fostering use of a power generation mix consistent with its most suitable energy mix.

III. ELECTRICITY SUPPLY AND DEMAND

1. Demand

Japan's gradual economic recovery continued in fiscal 2016 as real GDP grew by 1.2% from fiscal 2015 (when real GDP rose 1.4% from a year earlier). The unemployment rate also improved, falling 0.3 percentage points to 3.1% from 3.4% a year earlier.

Power consumption[1] in Japan has either declined or remained largely unchanged since reaching 1,007.7 TWh in 2007, and in fiscal 2016 came to 963.1 TWh. This trend is attributable to several factors, including the slowing of economic growth, improved energy conservation, and demographic decline. More recently, however, growing solar power generation in the residential sector, which these statistics do not capture, also appears to have played a part.

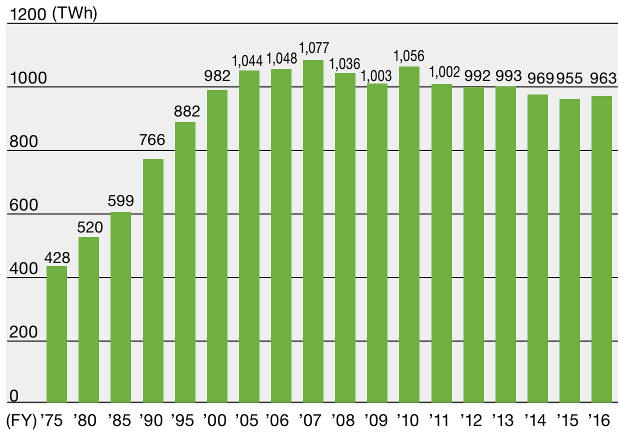
1. This includes self-generated power consumption (business sites with self-generating capacity of at least 500 kW up to fiscal 2002, and at least 1,000 kW from fiscal 2005 on).

2. Supply

Electric power generated came to 998.1 TWh in fiscal 2016. The progressive shutdown of nuclear power plants following the March 2011 earthquake increased dependence on thermal power plants and caused thermal's share of power generated to rise from 66.7% in fiscal 2010 to 85.4% in fiscal 2016. While nuclear power's share stood at 24.9% in fiscal 2010, the shutdown of all nuclear power plants in September 2013 caused this figure to drop to 0% in fiscal 2014 while thermal's share rose to 90.7%. Since the restart of Kyushu EPCo's Sendai Nuclear Power Plant in August 2015, several other plants have gradually come back online. However, nuclear's share of power generated in fiscal 2016 was still only 1.7%.

On the other hand, the construction of renewable energy installations such as wind and solar power plants has increased. In fiscal 2016, 5,457 GWh of electric power was generated by wind power, and 11,074 GWh by solar power. Although wind power was first introduced in the 1990s, growth has been sluggish in recent years, increasing by only around 13% over the past five years. Solar power, on the other hand, has grown rapidly despite not entering the mix until around 2005. Following the launch of the FIT scheme in July 2012, solar power

Figure 3.1 Changes in Power Consumption, 1975-2016



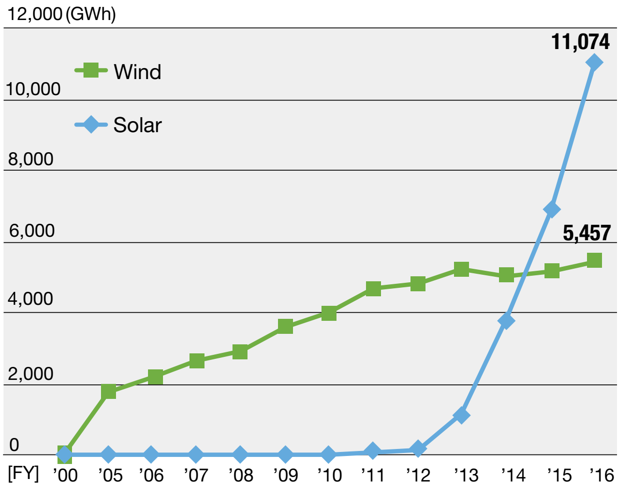
Data: Electric Power Industry Handbook

Figure 3.2 Power Generation Mix, 1975-2016

Data: Electric Power Industry Handbook

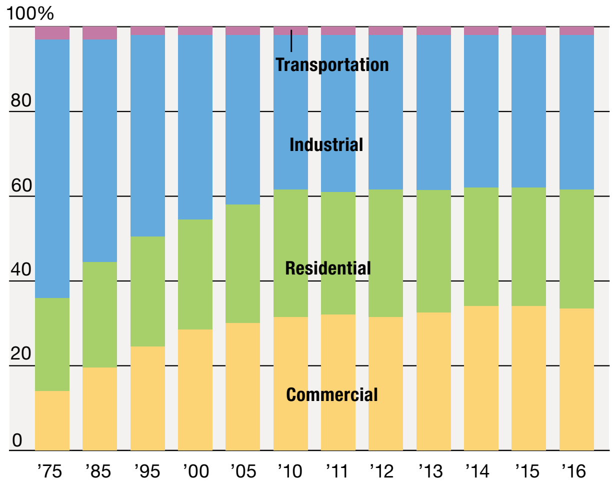
*Figures on electric power generated for electric utilities are generation-end figures through fiscal 2015, and transmission-end figures for fiscal 2016. Where the main fuel used is biomass or waste, power generated is respectively counted under biomass or waste.

Figure 3.3 **Wind and Solar Power Generation**



Data: Electric Power Industry Handbook
Note: Figures on electric power generated for electric utilities are generation-end figures through fiscal 2015, and transmission-end figures for fiscal 2016.

Figure 3.4 **Breakdown of Power Consumption by Sector, 1975-2016**



Note: The method of calculation was changed in fiscal 1990.
Source: Compiled based on Agency for Natural Resources and Energy, *Energy White Paper 2018*.

installations have surged, with solar output surpassing output from wind power installations in fiscal 2015. In fiscal 2016, twice as much power was generated by solar power than by wind power.

Looking ahead, the Basic Energy Plan adopted by the METI in July 2018 set power generation targets for 2030 calling for 22%-24% of electric power to be generated by renewables (including hydropower), 20%-22% by nuclear power, and about 56% by thermal power (27% LNG, 26% coal, and 3% oil).

3. Characteristics of Electric Power Supply and Demand in Japan

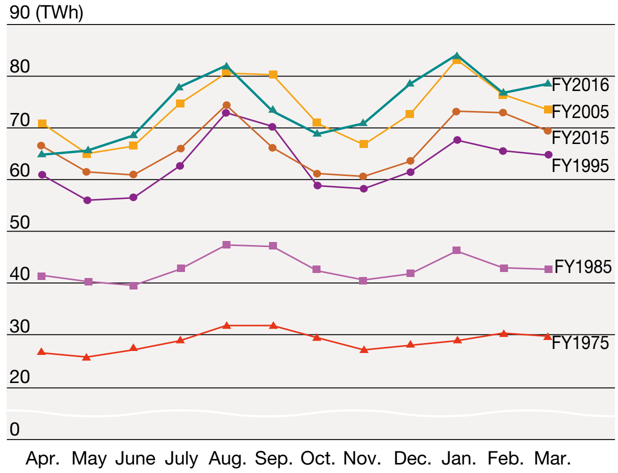
Electric power demand in Japan rose almost continuously as the economy grew following World War II. Since 2011, however, growth has leveled off, due mainly to the slowing of economic growth, demographic decline, and improved energy conservation. Peak national demand came to 155,890 MW in fiscal 2016.

Power consumption breaks down by use as follows: 34% commercial demand, 28% residential demand, and 37% industrial demand. Industry remains the largest consumer of electricity. Since the 1990s, however, industrial demand has entered a downward trend due to sluggish output in the materials sector and growing energy conservation. Over the longer term, the growth in consumption has thus been powered by consumption in non-industrial sectors, namely the commercial and residential sectors. Growth in consumption in the commercial sector has been propelled by growth in office buildings and the rapid spread of office automation equipment. In the residential sector, the rapid spread of heating and cooling appliances, such as air conditioners and electric carpets, and other household appliances driven by rising living standards ensured that power consumption continued to grow until fiscal 2005. Growth then leveled off as appliance ownership reached a saturation point and energy-saving devices began to capture a growing share of the market. In fiscal 2011, increased awareness of the importance of saving electricity in the aftermath of the Fukushima Daiichi Accident caused consumption to go into decline. In fiscal 2016, non-industrial consumption accounted for 62% of final power consumption.

The proportional rise in non-industrial demand has resulted in higher demand in the summer and winter due to demand for heating and air-conditioning. There are consequently wider differences in demand between winter and summer periods and other seasons than before (Figure 3.5), and also between daytime and nighttime hours (Figure 3.6).

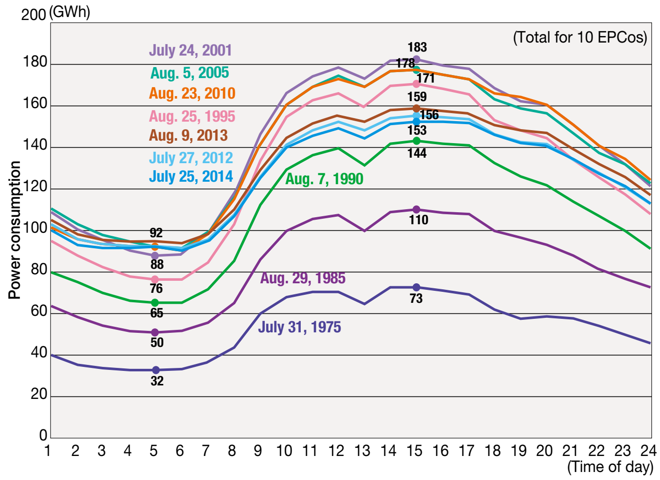
Efficiency of use of generation facilities worsens as variation in demand widens, pushing up power supply costs. Nevertheless, the annual load factor (i.e., the ratio of annual average load to annual peak load), an indicator of the efficiency of use of generation facilities, has actually improved to between 60% and 70% since the mid-2000s. This is thanks in large part to the introduction of flexible seasonal and time-of-day pricing, and the promotion of technologies such as heat pumps that use electricity during nighttime hours.

Figure 3.5 Electric Power Consumption over the Course of a Year



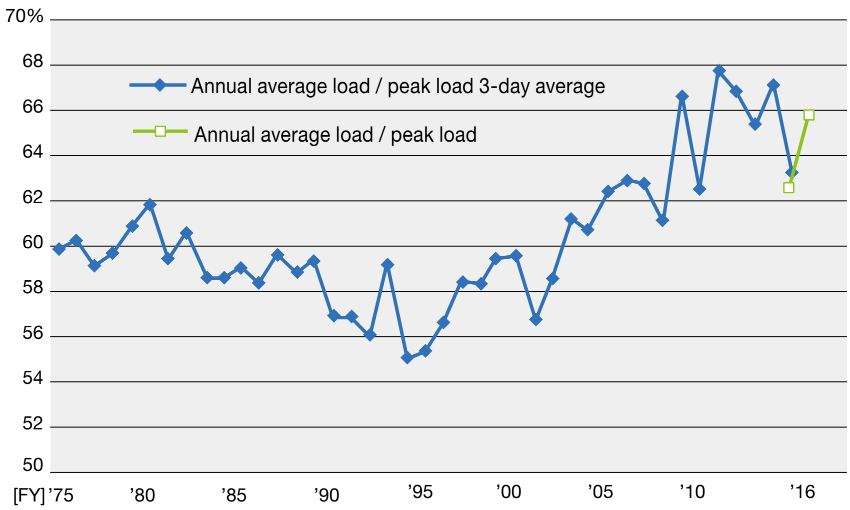
Note 1: Figures for fiscal 1975 and 1985 exclude Okinawa EPCo.
Note 2: Figures are totals for 10 EPCos through fiscal 2015, and for 10 areas in fiscal 2016.
Source: Compiled based on Agency for Natural Resources and Energy, *Energy White Paper 2018*.

Figure 3.6 Power Consumption over the Course of Days on Which Peak Loads Occurred



Note: Figures for fiscal 1975 exclude Okinawa EPCo.
Source: Agency for Natural Resources and Energy, *Energy White Paper 2018*

Figure 3.7 Annual Load Factor, 1975-2016



Source: Agency for Natural Resources and Energy, *Energy White Paper 2018*

4. Electricity Supply and Demand Measures

(1) Recent Developments

Seven years since the Great East Japan Earthquake, Japan's electricity supply and demand situation is improving. Due to the prolonged shutdown of nuclear power plants, however, the country still remains dependent on thermal power to ensure a stable supply of electricity.

More recently, Japan has also been experiencing the so-called "duck curve" problem caused by the increasing amount of electricity generated by solar power plants during the day. In addition to addressing this problem by limiting output from thermal plants during daylight hours, using excess power to pump up water for pumped storage, and supplying electricity to other service areas via interregional interconnections, utilities in Kyushu have also curbed output from solar power plants on several occasions during low load periods.

(2) Supply and Demand Projections

After factoring in the risk of demand growth caused by heat waves or severe winters and the extent of the normalization of the ongoing power conservation efforts being made by consumers since 2011, it has remained possible in recent years to maintain the minimum 3% reserve margin needed to ensure supply continuity in all areas of Japan.

Storage battery pilot plant at Minamisoma Substation (Tohoku EPCO)

The large-scale lithium-ion battery system with an output of 40 MW and a capacity of 40 MWh has been installed and connected to the power grid to study the potential for deploying further renewables by improving the balance of supply and demand.

(3) Procurement of Balancing Reserve

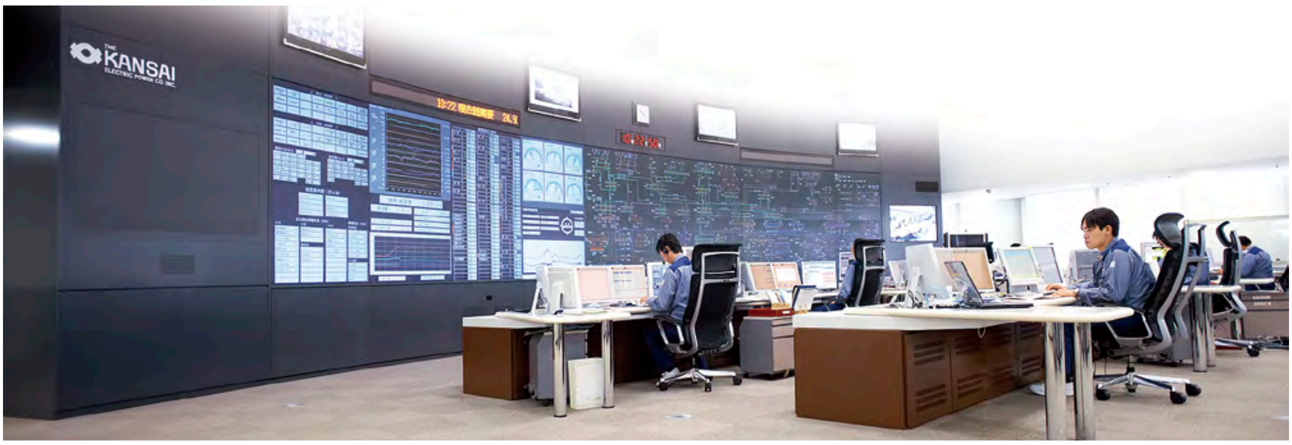
Electricity retail suppliers have to be able to always match supply and demand, and must secure the necessary supply capacity to do so. It falls upon the regional electricity network operators to secure the supply capacity required to be able to deliver adequate electricity to retailers to meet supply and demand fluctuations. Owing to the separation of generation and transmission following the introduction of a licensing system in April 2016, since fiscal 2017 the capacity required to balance supply and demand has been procured by tenders conducted by regional electricity network operators in order to ensure that balancing capacity is procured in a fair and transparent manner.

The balancing power procured is of two main types: power source I, which consists of power provided by dedicated sources of balancing power that are always available to regional electricity network operators; and power source II, which consists of surplus power from sources that can be used following gate closure for retail power sources. Demand response as well as power output is procured to ensure that the system can cope with severe weather and similar circumstances.

In fiscal 2018, 11,300 MW of power source I and 142,960 MW of power source II were procured (as of January 2018). Nine hundred sixty MW of demand was met by demand response.

In September 2017, lower than expected solar power output led to a total of 70 MW of demand being met by demand response in the Kyushu area. In 2018, record low temperatures from the end of January to the beginning of February led to demand response being performed in the Tokyo area a total of 13 times on eight days, while in July, the tight supply and demand situation due to a heat wave led to demand response being used in the Kansai area.

In September 2018, a power outage hit the whole of Hokkaido following an earthquake. EPCos from across Japan sent truck-mounted generators, mobile elevating work platforms, and other resources to assist the rapid restoration of service.



Central Load Dispatching Center (Kansai EPCo)

IV. POWER GENERATING FACILITIES

As a nation with limited natural energy resources, Japan depends on imports to satisfy nearly all of its energy needs. Since the first oil crisis of 1973, the electric power industry has placed a priority on reducing Japan's dependence on oil by introducing nuclear, coal-fired, LNG-fired and hydro power plants, while also developing renewable energy sources with the aim of achieving an optimal mix of power sources.

1. Power Generating Facilities for Electric Utilities

(1) Thermal Power

Regarding thermal power, the industry is pursuing efforts to diversify fuel sources, including coal and LNG, from an energy security perspective. As of the end of March 2017, the total installed capacity of thermal power plants excepting self-generated power was 174,390 MW.

Coal-fired capacity came to 45,910 MW, and coal-fired power plants are undergoing various improvements to ensure that they can continue to fulfill their role as baseload and medium-load electric power sources. These include installation of large-capacity units, ultra-supercritical pressure boilers, and variable pressure operation equipment to enhance their efficiency and load-following capabilities. This has positioned coal-fired thermal power plants as one of the most economically efficient power sources. Technologies designed to further boost the efficiency of coal-fired plants, including advanced ultra-supercritical (A-USC) facilities, integrated coal gasification combined cycle (IGCC) facilities, integrated coal gasification fuel cell combined cycle (IGFC) facilities, and carbon capture and storage (CCS) facilities, are currently under development and moving toward practical application.

LNG capacity came to 80,260 MW. LNG-fired power plants produce lower SOx, NOx, and CO_2 emissions than oil- and coal-fired plants, and construction of large-scale LNG plants employing high-efficiency combined-cycle technologies is underway. New plants recently added to the grid exhibit significant improvements in performance, with gas turbine inlet temperatures of 1,600°C and thermal efficiency of approximately 63% (LHV). The superior load-following capability and highly economical operation achieved by LNG-fired plants make them excellent sources of energy.

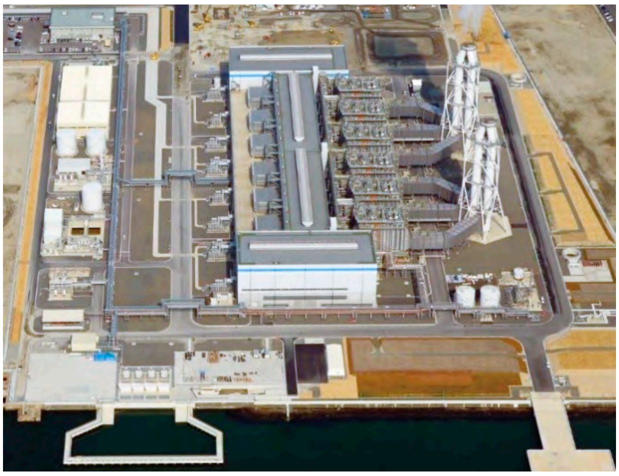
Oil-fired capacity came to 37,230 MW. Large numbers of oil-fired power plants were built during Japan's high growth period when oil prices were low, and capacity at its peak reached 59,240 MW. Capacity subsequently declined, however, due primarily to the effects of the oil crises. The current administration is also promoting the use of highly economical coal power plants alongside environmentally friendly LNG power plants with their excellent load-following capabilities, and closures

KAWASAKI Thermal Power Station (TEPCO Fuel & Power, Inc.)

Units 2 and 3 entered operation in January and June 2016 respectively. Both are 1,600°C-class combined cycle power plants, and have achieved the world's best generating efficiency of approximately 61%.

Shin-Sendai Thermal Power Station (Tohoku EPCO)

No.3 Series commenced full-scale commercial operations in July 2016. This replacement project received 2017 International Edison Award from the Edison Electric Institute of the United States in recognition of contributing to the electric industry-wide development, such as achieving the project for co-prosperity with local communities and developing the highly-efficient power generation facilities superior in both environmental performance and countermeasures against disasters.



Nishi-Nagoya Thermal Power Station (Chubu EPCo)

The station Unit 7-1 has achieved 63.08% power generation efficiency and it was recognized by the Guinness World Records as the world' s most efficient combined cycle power plant.
(All units of Nishi-Nagoya Thermal Power Station went into operation on March 30, 2018.)

of oil-fired power plants are expected to continue.

By thus introducing and making appropriate use of high-efficiency thermal power generation, the gross thermal efficiency of all thermal power plants in Japan was maintained at a world-class level of 42.9% (on an HHV basis) in fiscal 2015.

(2) Nuclear Power

Nuclear power is currently employed as a baseload power source. As of the end of September 2018, no nuclear power plants have been added to the grid since fiscal 2010, and this, combined with the decommissioning of six reactors at the Fukushima Daiichi Nuclear Power Plant (Units 1 to 4 in April 2012 and Units 5 and 6 in January 2014) and nine old reactors at other plants between 2015 and 2018, had reduced the number of installed reactors to 39 units (not including three reactors under construction). Japan's total nuclear generating capacity of 38,570 MW ranks fourth in the world after the United States, France, and China. The capacity factor had been maintained at the 80% level through fiscal 2001, but it subsequently fell following the Fukushima Daiichi Accident of March 2011, after which units whose operation had been suspended for periodic inspections were unable to restart. As a consequence, the capacity factor progressively declined, eventually sinking to zero in fiscal 2014.

Following final inspection by the Nuclear Regulation Authority, however, a total of nine reactors have now come back online: Unit 1 at the Sendai Nuclear Power Plant (which reentered commercial operation in September 2015), Unit 2 at the same plant, Unit 3 at the Ikata Nuclear Power Plant, Units 3 and 4 at the Takahama Nuclear Power Plant, Units 3 and 4 at the Ohi Nuclear Power Plant , and Units 3 and 4 at the Genkai Nuclear Power Plant. As another five reactors have received approval for their installation licenses to be amended and 11 reactors (excluding the reactor at the Oma Nuclear Power Plant currently under construction) are having their compliance with the new regulatory standards reviewed, nuclear power output is expected to continue to recover in the months and years ahead. (See Chapter I for details.)

(3) Hydro Power

Hydro power is employed as both a base power source and a power source for responding to peak-load conditions. As of the end of March 2017, the total installed capacity of hydro power plants excepting in-house facilities in Japan was 49,520 MW, of which pumped storage power facilities accounted for about 56%. All

Okutataragi Hydro Power Plant (Kansai EPCo)

Katakai Betsumata Hydro Power Station (Hokuriku EPCo)

but two of the 27 hydro power plants with maximum capacities of 400 MW or above were pumped storage plants.

(4) Renewable Energy

Renewables (excluding hydro) are seeing increasing adoption as environmentally friendly energy sources. Although the Renewables Portfolio Standard (RPS) Act implemented in fiscal 2003 mandated the use of certain amounts of renewable energy, development was initially lackluster. In fiscal 2010 renewables (excluding hydropower) still accounted for only about 1.2% of generated output. A new feed-in tariff (FIT) scheme for renewable energy was therefore launched in July 2012. This prompted a surge in the adoption of renewables (especially solar power), with purchases of renewable energy reaching approximately 1.84 trillion yen in fiscal 2015. As this figure is projected to continue to rise, the mechanism used to determine purchase prices for renewables was revised in February 2016. (See Chapter I for details.)

As of the end of December 2017, a total of 42,800 MW of feed-in-tariff certified solar power generating capacity (including systems operated by non-utility generators) had been installed in Japan, and wind power plants with a total generating capacity of 3,370 MW were in operation.

2. Future Plans

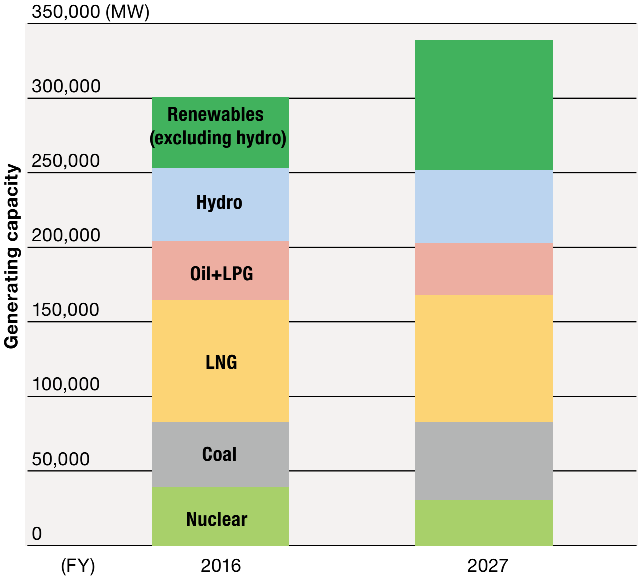
The "Aggregation of Electricity Supply Plans for FY2018" published in March 2018 by the OCCTO calls for the development of a total of 23,500 MW (excluding nuclear power and renewables other than hydropower) of new power sources from fiscal 2018 to 2027. A

Table 4.1 Major Power Development Projects (As of March 2017, Output of 400 MW or Above)

Utility	Type	Plant name	Output (MW)	Class* (scheduled)	Start of operation
Hokkaido EPCo	LNG	Ishikariwan-Shinko Units 1 to 3	1,708	1,600°C class CCGT	Feb. 2019 (Unit 1), Dec. 2026 (Unit 2), Dec. 2030 (Unit 3)
Tohoku EPCo	Coal	Noshiro Unit 3	600	USC	Jun. 2020
	LNG	Joetsu Unit 1	572	CCGT	Jun. 2023
Tokyo EPCo**	Hydro	Kannagawa Units 3 to 6	1,880	Pumped storage	From fiscal 2028 onward
	Hydro	Kazunogawa Unit 3	400	Pumped storage	From fiscal 2028 onward
Chubu EPCo**	LNG	Nishi-Nagoya Unit 7 series	2,376	1,600°C class CCGT	Sep. 2017 (Unit 7-1), Mar. 2018 (Unit 7-2)
	Coal	Taketoyo Unit 5	1,070	USC	Mar. 2022
Hokuriku EPCo	LNG	Toyama Shinko LNG Unit 1	424.7	1,500°C class CCGT	Nov. 2018
Kansai EPCo	LNG	Wakayama	3,700	—	From fiscal 2027 onward
Chugoku EPCo	Coal	Misumi Unit 2	1,000	USC	Nov. 2022
Shikoku EPCo	Coal	Saijo Unit 1(replaced)	500(+344)	USC	2023
Kyushu EPCo	Coal	Matsuura Unit 2	1,000	USC	Dec. 2019
J-POWER	Coal	Takehara New Unit 1	600	USC	Jun. 2020
JERA	Coal	Hitachinaka Generation	650	USC	2020
	LNG	Goi	2,340	1,650°C class CCGT	2023
	LNG	Anegasaki	1,950	1,650°C class CCGT	2023
	Coal	Yokosuka	1,300	USC	2023

*Abbreviations used are as follows:
CCGT: Combined Cycle Gas Turbine; USC: Ultra Super Critical; SC: Super Critical.
Dashes are used where the type is unknown.
**Tokyo EPCo and Chubu EPCo thermal power plants transferred to JERA effective April 1, 2019.
Source: Summaries of supply plans published by utilities (excluding nuclear energy, which remains undecided) and other sources.

Figure 4.1 **Generating Capacity by Power Source, 2016-2027**



Source: OCCTO

breakdown of this volume shows that 279 MW is to be provided by hydro power generation and 17,420 MW by thermal power generation (Figure 4.1).

Electricity producers are also actively adopting utility-scale solar power generation and building large-scale commercial solar power plants. In the area of wind power generation, they are investigating locations with appropriate wind conditions and promoting facility installation. However, solar and wind power generation also present numerous challenges, including the instability of power generation due to variable natural conditions and the impact of their operations on the supply and demand balance.

V. POWER NETWORK FACILITIES

1. Transmission Facilities

Japan's bulk transmission systems comprise 500 kV, 275 kV, 220 kV, 187 kV, 154 kV and 132 kV transmission lines. The maximum transmission voltage is 500 kV for all EPCos except Hokkaido EPCo (275 kV) and Okinawa EPCo (132 kV).

As of the end of March 2017, these transmission lines had a total circuit length of approximately 179,000 km.

Japan's three major metropolitan areas, Tokyo, Osaka and Nagoya, are served by bulk transmission systems comprising dual 500 kV outer ring transmission lines with additional bulk lines connected to the rings in a radial pattern. In the Tokyo Metropolitan Region, Tokyo EPCo has constructed transmission lines designed to handle up to 1,000 kV as a third outer ring, which is currently operating at 500 kV. Extra-high voltage underground transmission cables (500 kV, 275 kV and 220 kV) are also being installed to enhance the reliability of the power supply to the central districts of large cities.

As of the end of March 2017, the circuit length of underground transmission cables with normal voltages of 187 kV or higher was approximately 1,860 km, while underground transmission cables accounted for 15.2% of the total circuit length of the transmission lines in the network (Table 5.1).

DC transmission lines are used for the interconnections between Hokkaido and Honshu, and between Kansai and Shikoku.

2. Substation Facilities

The adoption of gas-insulated switchgears is facilitating the construction of more compact substations to meet the needs of today's increasingly congested cities. In November 2000, Tokyo EPCo initiated operation of the Shin-Toyosu Substation, the world's first 500 kV

Table 5.1 Total Circuit Length of Transmission and Distribution Lines and Transformation Facility Capacities

	1975	1985	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
Circuit length of transmission lines (km)*												
Under 110kV	69,361	78,660	88,648	94,762	95,176	104,618	105,038	105,128	105,327	105,804	106,167	106,238
110kV – Under 220kV	28,913	35,106	36,952	36,669	35,962	35,696	35,635	35,561	35,566	35,505	35,588	35,709
220kV or above	14,167	23,486	29,107	33,232	35,209	35,791	36,690	36,701	36,658	36,848	36,949	36,845
Total	112,441	137,252	154,707	164,663	166,347	176,105	177,363	177,390	177,551	178,157	178,704	178,792
Substation output capacity (MVA)*	234,748	447,866	657,536	748,258	778,740	810,924	813,782	821,087	826,015	830,116	833,112	842,084
Total Number of substation	3,466	5,152	5,814	6,394	6,570	6,686	6,697	6,698	6,701	6,705	6,718	6,766
Circuit length of distribution lines (km)*												
Overhead	2,623,787	3,179,970	3,661,963	3,827,612	3,918,743	3,966,677	3,967,914	3,975,171	3,985,241	3,995,650	4,005,974	4,015,703
Under-ground	14,358	25,348	50,371	59,164	65,287	66,896	67,711	68,548	69,358	70,025	70,733	71,360
Total	2,638,145	3,205,318	3,712,334	3,886,776	3,984,030	4,033,573	4,035,625	4,043,719	4,054,599	4,065,675	4,076,707	4,087,063

*Figures are as of fiscal year-end.
Note: Figures for 1985 and later include Okinawa EPCo.
Source: FEPC


Removing snow from power lines (Hokkaido EPCo)


Maintenance of transmission systems (Chugoku EPCo)

underground substation.

As of the end of March 2017, the total capacity of the transformers installed in the 6,766 substations operated by the 10 EPCos was 842,084 MVA. Widespread introduction of remote-control systems has reduced the number of operators required for substations.

3. Distribution Facilities

The standard for high-voltage distribution systems is the 6 kV multi-divided, multi-connected system. Either 22 kV or 33 kV spot network systems are installed in densely populated areas to prevent equipment overcrowding and improve power supply reliability. In principle, electricity is supplied to low-voltage customers through 100/200 V single-phase three-wire or 200 V three-phase three-wire systems. Low voltage distribution lines are thus generally installed in three-phase four-wire open-delta connection distribution systems used to supply both single-phase and three-phase power.

As of the end of March 2017, the total length of distribution lines in Japan was approximately 4,087,000 km. Of this, 71,000 km (1.8%) consisted of underground lines (Table 5.1).

Efforts to improve supply reliability and business operating efficiency in the distribution sector include the widespread use of distribution automation systems for remote supervision and automatic control of distribution equipment. In response to the recent growth of distributed generation, switches with sensors and static automatic voltage regulators (such as STATCOMs) are increasingly being installed on distribution lines in order to maintain supply reliability and power quality.

Smart meters for low-voltage customers have been installed in order to (1) assist electric power companies' meter reading work, (2) track individual customers' electricity usage so as to facilitate power-saving measures, and (3) provide a means of limiting power consumption when the supply and demand balance is tight. Smart meters had been installed in about 34% of households as of March 2017, and all customers should have smart meters by the end of the 2020s.

4. Telecommunications Networks

Telecommunications networks serve as the EPCos' nervous system, providing efficient, reliable control of increasingly diversified, higher capacity electric power facilities. The EPCos have established their own telecommunications network for electric power supply control, successfully integrating their electric power supply and telecommunications network operations. Moreover, they have ensured a high level of information security by avoiding direct connection of their control telecommunications network with the internet or other external networks.

Today, the EPCos' telecommunications networks are constructed primarily of optical fiber cables that connect regionally dispersed electric power plants and other electric facilities with single or multiple routes and facilitate efficient transmission of requisite information to their control facilities.

Moreover, enhanced electric power system control and supervision have been achieved by constructing disaster-resistant, dedicated microwave radio transmission networks, the majority of which are highly-reliable networks comprising two routes. Microwave radio line links are also employed to transmit information through interconnections among multiple EPCos in areas where electric power systems operated by more than one EPCo are linked.

5. Cross-Regional Operation and System Operation

The Japanese power grid is divided into two frequency systems: a 50 Hz system in eastern Japan and a 60 Hz system in western Japan. All the EPCos, except Okinawa EPCo, are connected to the grid. The frequency difference is said to date back to 1896, when 50 Hz German-made power generation equipment was introduced in eastern Japan and 60 Hz U.S.-made equipment in western Japan.

In eastern Japan, Tokyo EPCo and Tohoku EPCo are linked by 500 kV AC transmission lines, while Tohoku EPCo and Hokkaido EPCo are linked by ±250 kV DC submarine cables. In western Japan, Chubu EPCo, Hokuriku EPCo, Kansai EPCo, Chugoku EPCo, Shikoku EPCo and Kyushu EPCo are linked by 500 kV AC transmission lines. Chubu EPCo and Hokuriku EPCo are also connected by back-to-back DC linkage facilities (300 MW), while Kansai EPCo and Shikoku EPCo are linked by ±500 kV DC submarine cables (operating for the time being at ±250 kV). The 50 Hz and 60 Hz systems are linked by the interconnections between the Tokyo EPCo and Chubu EPCo networks (Sakuma Frequency Converter (300 MW), Shin-Shinano Frequency Converter (600 MW), and Higashi-Shimizu Frequency Converter (300 MW): total 1,200 MW) (Figure 5.1). OCCTO plays the lead role in considering plans to enhance these interconnections taking into account the individual utilities' views. Enhancement work on the Hokkaido-Honshu interconnection (600 MW →900 MW) began in April 2014, while enhancement of the Tokyo-Tohoku interconnection is in the planning stages. It has been decided that the Shin-Shinano Frequency Converter at the Tokyo-Chubu interconnection will be upgraded by 900 MW by fiscal 2020, and plans are being made for a total of 900 MW across the Sakuma and Higashi-Shimizu Frequency Converters. (Total 1,200 MW → 2,100 MW → 3,000 MW)

Worksite of refurbishing 275 kV Higashi-Nagoya Tobu Line in progress in Toyota City, Aichi (Chubu EPCo)

The project involves rebuilding the steel towers and replacing the electric wires under the many restrictions imposed in urban areas.

The individual EPCos are responsible, in principle, for handling their own system operation and mainly compensate for load fluctuations on their own grids using their own generating sources. However, they do cooperate with each other across different control areas in efforts to improve economic efficiency and ensure a stable power supply by developing optimal power sources, conducting capital investment and exchanging power to benefit from differences in regional characteristics and demand structures.

In June 2015, the Electricity Business Act was revised to provide for full liberalization of the retail market and the introduction of a new licensing system in order to put into effect the second stage of the reform of Japan's electricity industry. To ensure fair access, the balancing capacity required to deliver ancillary services has since October 2016 been procured by regional electricity network operators from electricity producers through a system of public procurement.

Use of the interconnections that span the service areas of different transmission and distribution operators is administered by the OCCTO. Traditionally, market participants have been allowed to use these interconnections on a first-come, first-served basis. However, in October 2018 this first-come, first-served model was abandoned, and an implicit-auction approach introduced under which, in principle, use of the interconnections will be assigned based on contracts concluded in the day-ahead market. The introduction of these new rules should expand the use of interconnections by new market participants and put in place a fair and competitive environment, while at the same time enabling cross-regional merit orders. Through these measures, it is hoped that increases in electricity rates can be held to a minimum, and additional business opportunities created for market participants.

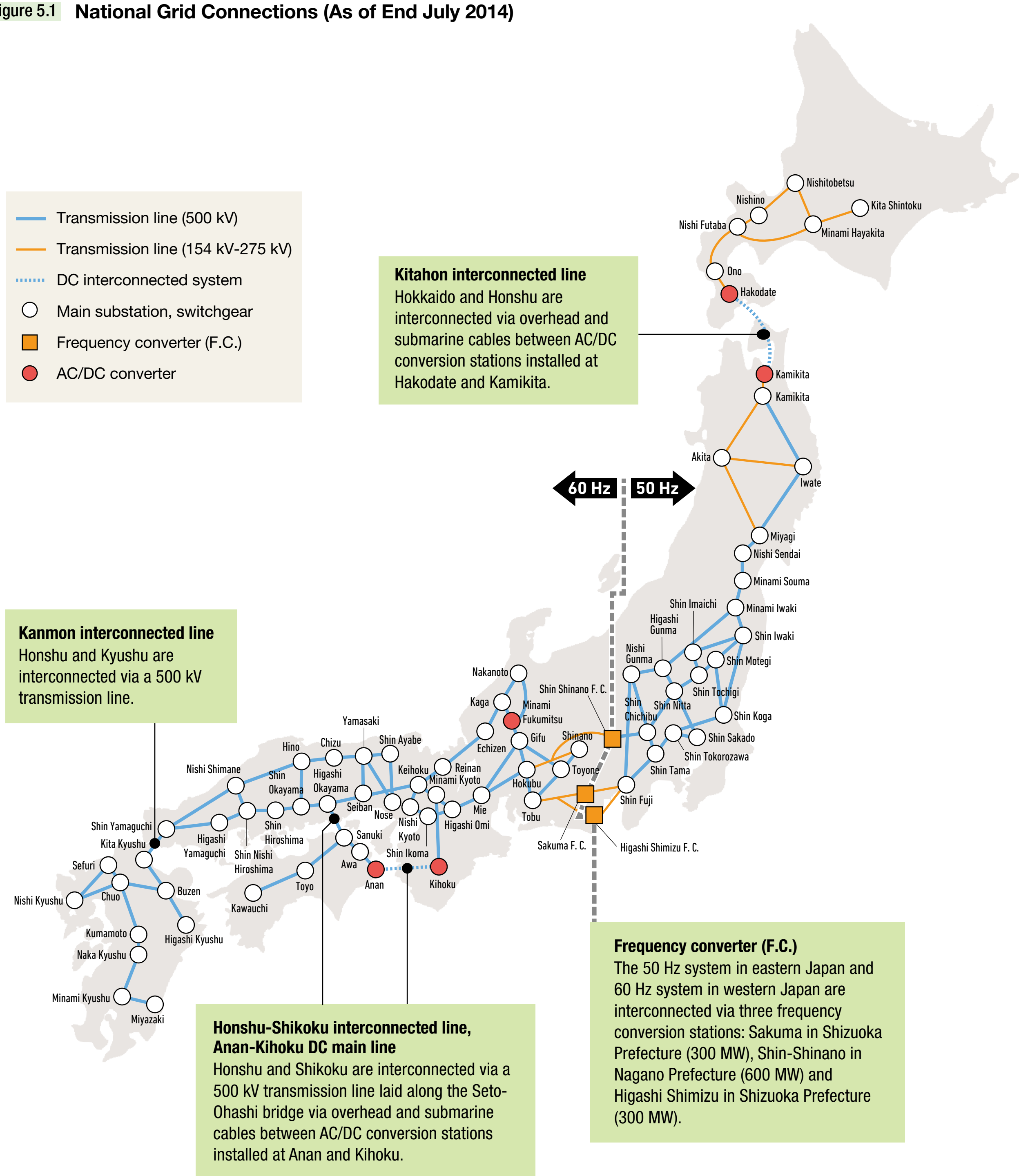
The OCCTO has developed a long-term policy that sets a course for developing and updating Japan's cross-regional interconnection systems on a nationwide scale. In this process it has identified the following three key issues for facilities formation over the mid- and long-term.

1. Growth in electricity demand is slowing.

2. If new interconnection needs are to be addressed through the conventional approach to facility formation and grid use, it will require a huge update in transmission and distribution facilities.
3. This will result in a reduced efficiency for transmission and distribution facilities, with inevitable upward pressure on wheeling charges.

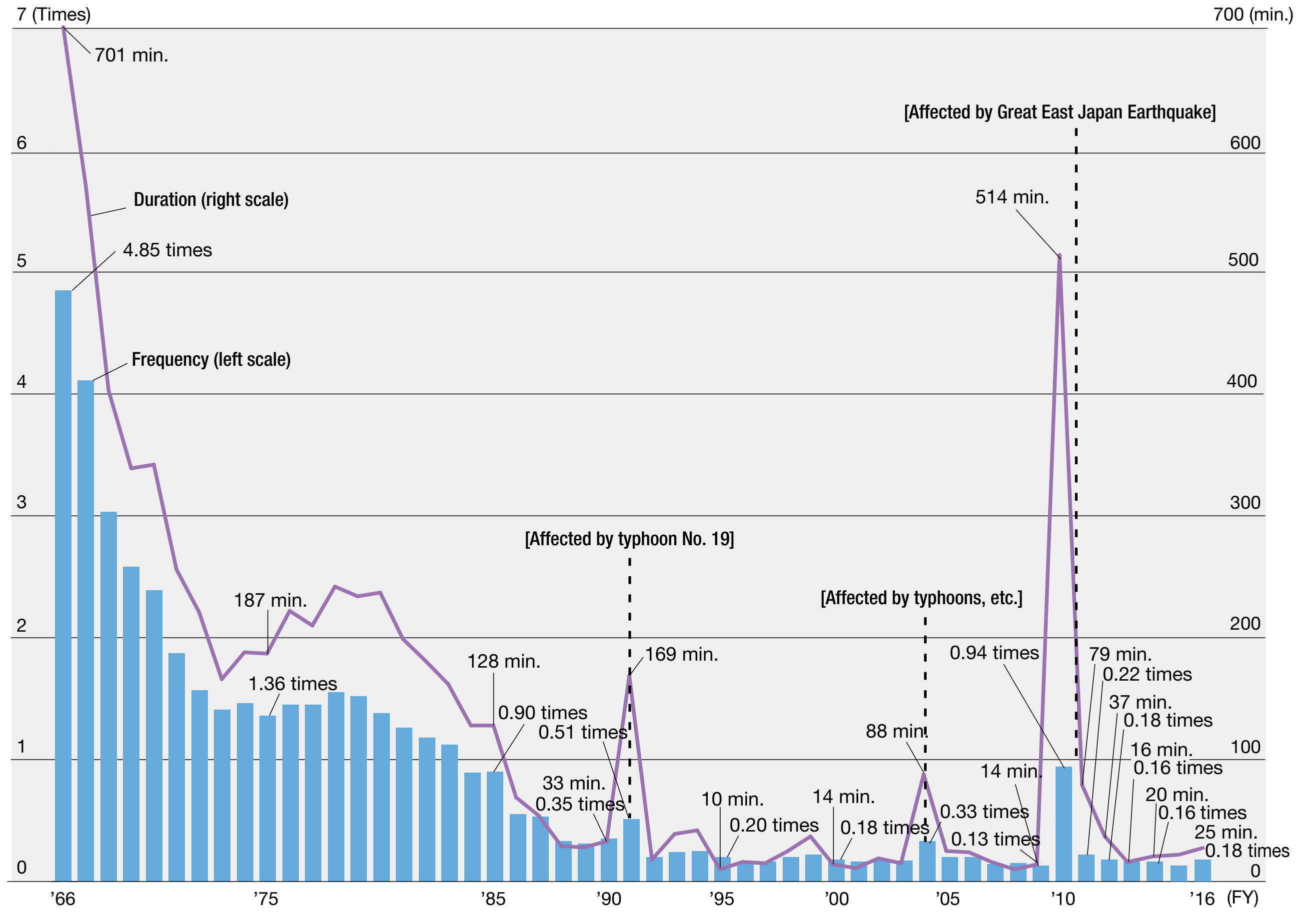
For this reason, the OCCTO is calling for a pivot from the previous approach of making reinforcements to the grid in response to interconnection capacity. Premised on more efficient facilities formation through the maximum possible utilization of already existing facilities, the OCCTO is developing a new concept for transmission and distribution facilities formation that can be described as a Japanese-version of the “Connect and Manage” model.

Figure 5.1 National Grid Connections (As of End July 2014)



Source: FEPC

Figure 5.2 **SAIFI and SAIDI per Customer (Total for 10 EPCos)**



Note: 9 EPCos up to FY1988
Source: FEPC

6. Supply Reliability

Supply reliability is being greatly improved by conducting patrols to prevent outages in advance as well as developing network facilities as outlined above. Since the 1990s, a high level of supply reliability has been maintained except during major disasters such as the Great East Japan Earthquake. In fiscal 2016, SAIFI (System Average Interruption Frequency Index) was just 0.18 interruptions per customer and SAIDI (System Average Interruption Duration Index) only 25 minutes per customer (Figure 5.2).

VI. ELECTRICITY RETAIL BUSINESS

1. Electricity Rates

(1) Outline of Retailers

In April 2016, the scope of deregulation was extended to include the remaining regulated sector (contracted demand below 50 kW), thus completing the process of liberalization of Japan's electricity retail market. By 2018, two years after deregulation, the 10 former general electric utilities had been joined by new entrant power producers and suppliers (electricity retail suppliers), or PPSs, including companies from the telecommunications, trading, gas, oil, and steel industries as well as subsidiaries of leading electric utilities (Table 6.1). According to data published by the Agency for Natural Resources and Energy, a total of 507 companies (including the retailing arms of leading electric utilities) had registered as retail suppliers as of September 20, 2018, an increase of 17% from a year earlier. These new entrants are winning more customers in their own various ways, including by bundling electricity with other services.

Figure 6.1 shows trends in the volume of electricity sold by PPSs. As of May 2018, two years since full deregulation of the retail market, PPSs had captured 9.1% of low-voltage demand. At the same time, competition among the PPSs has intensified, with some suppliers either being forced out of the market or are being merged into leading electric utilities. The power companies that used to be known as "general electric utilities" are now referred to as "former general electric utilities," and electricity is now being sold by the retail sector of these utilities.

(2) Regulated Electricity Rates

Up until the full deregulation of the retail electricity market in April 2016, the EPCos had supplied electricity and in turn had accepted a legal obligation to supply regulated customers in accordance with provisions drawn up for standard electricity usage ("general supply provisions") and electricity usage contributing to load leveling ("optional supply provisions").

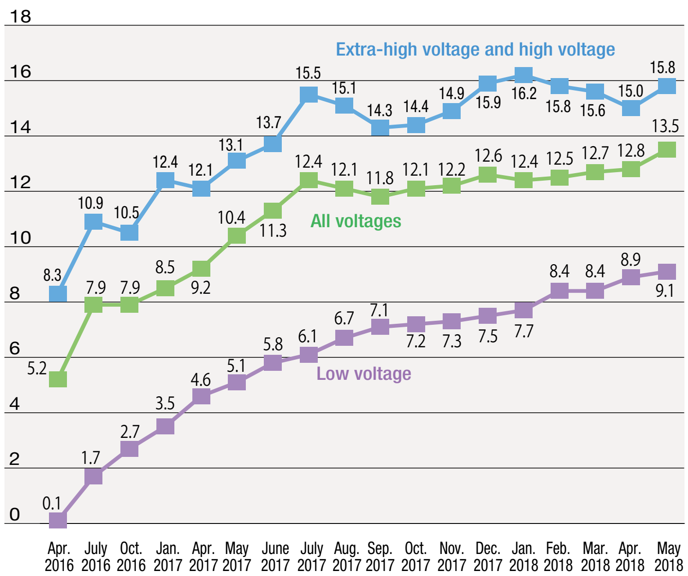
The electric utilities that had been regional monopolies required the permission of the Minister of Economy, Trade and Industry to raise their rates or make similar changes to the terms laid down in their general supply provisions, and also were required to report the changes that would benefit customers, such as rate reductions, to the minister. While many of these utilities raised their rates when nuclear power plants were shut down following

Table 6.1 **Top Ten PPSs by Total Electricity Sales (June 2017 to July 2018)**

	Company name	Electricity sales (MWh)
1	ENNET	12,978,599
2	F-Power.	11,023,499
3	Tepco Customer Service	8,089,367
4	JXTG Nippon Oil & Energy	5,994,439
5	Tokyo Gas	4,920,525
6	Marubeni Power Retail	4,773,587
7	KDDI	3,402,915
8	Osaka Gas	2,650,298
9	ORIX	2,624,565
10	Eneres Power Marketing	2,175,483

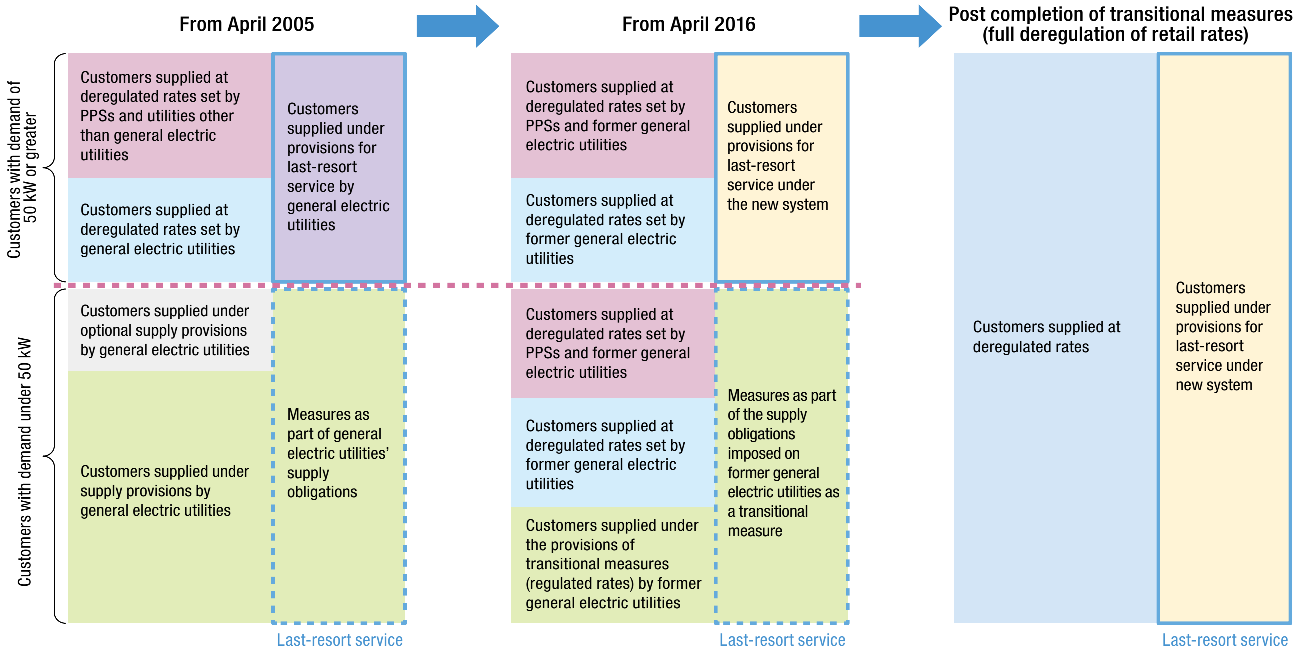
Source: Compiled from Agency for Natural Resources and Energy, METI, "Electric Power Demand."

Figure 6.1 **Trends in PPS Sales Share by Volume**



Source: Compiled from Agency for Natural Resources and Energy, METI documents.

Figure 6.2 **Arrangements to Bridge the Transition from Regulated to Deregulated Rates**



Source: Agency for Natural Resources and Energy, METI documents. Includes amendments.

the Great East Japan Earthquake in March 2011, some returned a portion of their profits to customers by lowering their rates again when the plants were restarted.

Even following the full liberalization of the retail market in April 2016, the regulated rates specified in utilities' general supply provisions remain in effect until at least March 2020 as a transitional measure to protect consumers. These regulated rates are seen as "transitional rates" that will apply until their abolishment.

As of June 2018, regulated rates were being paid by some 59.90 million meter-rate "residential use" customers (i.e., customers signed up to rate schedules for ordinary households), accounting for approximately 65% of all low-voltage contracts (including deregulated rates). However, the regulated rate schedules still include some other special rate schedules, such as schedules that were drawn up to offer affordable rates for limited agricultural uses in order to assist the development of Japan's agriculture following World War II.

One recent development regarding these regulated rates was the government decision in September 2018 to establish an expert body to consider the abolishment of transitional rates. This body is expected to engage in detailed discussion of the various topics that will need to be addressed before the regulated rates can be abolished, including the future shape of transitional rates under different rate schedules and conditions for special zones in which transitional rates will continue to apply, so as to better ensure the protection of customers' interests.

On the other hand, "optional supply provisions" have been newly assigned the role of determining the deregulated rates that will be described in a later section.

a. Contract Categories and Rate Structure

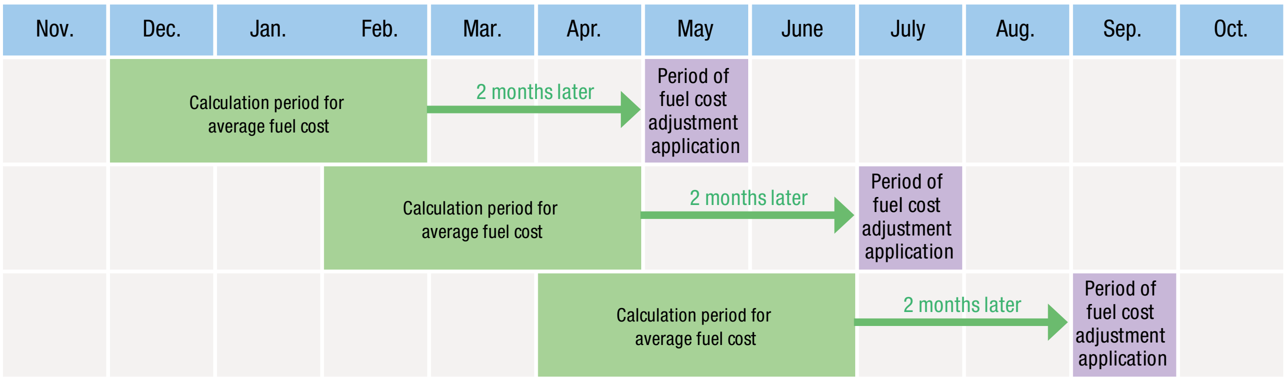
Regulated rates are calculated by the fully distributed cost method of determining rates based on the sum of necessary costs plus an appropriate return. Electricity contracts for regulated rates are classified according to electricity use (such as residential use or industrial purposes), and electricity supplied based on the "specific retail supply provisions" of the EPCo concerned. Electricity rates are in principle organized into two parts comprising demand charges (which are proportional to contract demand) and energy charges (proportional to energy consumption). These charges are calculated based on the unit electricity rates set for each contract category. Under this two-part system, rates are structured as indicated in Table 6.2.

Table 6.2 **Electricity Rates Structure in the Two-Part System**

Electricity rate = basic rate + unit electricity rate × electricity consumption ± fuel cost adjustment × electricity consumption + surcharges to encourage renewable energy generation × electricity consumption

Source: Federation of Electric Power Companies of Japan website.

Figure 6.3 **Fuel-Cost Adjustment Timeline (Example)**



Source: Federation of Electric Power Companies of Japan website.

For example, electricity demand for residential use is supplied at low voltage (single-phase 100/200 V) to users with contracted demand of less than 50 kW. Since 1974, the year following the first oil crisis, a three-tiered rate system has been employed to charge for electricity used for residential use in order to promote energy conservation.

Under this system, monthly electricity consumption is divided into three tiers. The first tier covers consumption up to 120 kWh, considered the amount necessary for daily life from the perspective of the national minimum, with a relatively low rate unit price applied. For electricity consumption in the second tier a unit rate corresponding to the average supply cost is applied and a slightly higher rate unit price is applied for electricity consumption in the third tier. The threshold between the second tier and third tier is set at 300 kWh (280 kWh for Hokkaido EPCo) reflecting typical electricity consumption by ordinary households. There is also a low-voltage contract category (three-phase, 200 V with contracted demand of less than 50 kW), which applies primarily to small factories.

b. Fuel-Cost Adjustment Scheme

A fuel-cost adjustment scheme was introduced in January 1996 for the purpose of clarifying the outcomes of the electric utilities' efforts to increase management efficiency, reflecting economic changes in rates as expediently as possible and stabilizing the electric utilities' management environment by externalizing the effects of fuel prices and exchange rates, which are beyond the control of the electric utilities in their efforts to enhance efficiency.

The fuel-cost adjustment scheme was revised in March 2009 in response to changing conditions in the operating environment of the electric utility industry, such as the sudden, steep fluctuations in fuel prices that occurred in 2008. Under the revised fuel-cost adjustment scheme, the period (time gap) before fuel price fluctuations are reflected in electricity prices has been shortened from three months to two months, the shortest period to date, and fuel price three-month averages are also now reflected in the electricity rates charged each month (For example, the average fuel prices for the period February-April are now reflected in the electricity rates for July of the same year). These changes enable the electric utilities to reflect changes in fuel prices in the rates they charge their customers more quickly than before, and to more effectively level rate fluctuations (Figure 6.3). Meanwhile the ceiling on automatic adjustments remains unchanged from before.

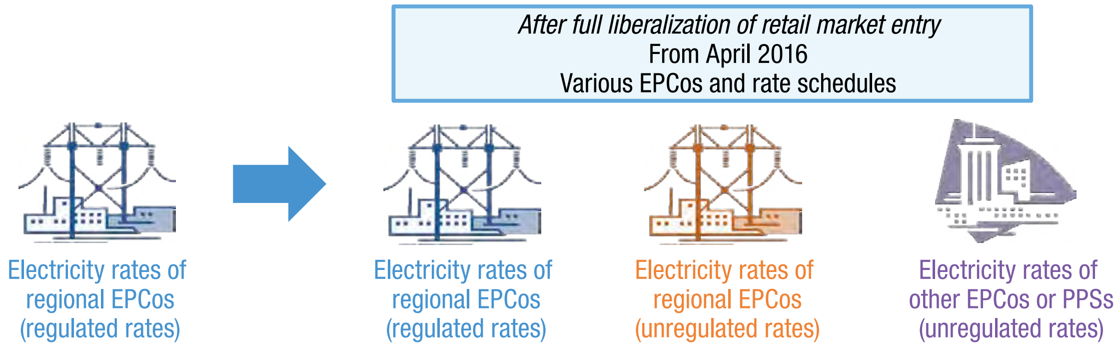
The fuel-cost adjustment scheme is not limited to regulated rates, and in some cases is also applied to the deregulated rates described below.

c. Feed-in Tariff Scheme for Renewable Energy

Under the July 2012 Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities, the EPCos are obligated to purchase electricity generated by renewable energy sources (solar, wind, hydroelectric, geothermal, and biomass) at a fixed price for a prescribed period. The EPCos can recover the cost via a surcharge calculated in proportion to the customers' usage volume, which is imposed to encourage renewable energy generation. This surcharge makes up a part of the electricity rate.[1]

1. Under the new system, premises engaged in business that have electricity consumption relative to turnover exceeding a level prescribed by law, and whose consumption over a year with respect to this business also exceeds a level prescribed by law are exempt from paying a portion of the surcharge. While the amount of the surcharge has been raised annually to encourage more renewable power generation, the reduction of the tariff as the use of renewables spreads has been impacting the management of renewable power producers.

Figure 6.4 Rate Choices Following Full Liberalization of Retail Market Entry



Source: Agency for Natural Resources and Energy, METI documents. Includes amendments.

(3) Unregulated Rates

High-voltage customers who were the target of deregulation prior to April 2016 are already able to freely select their suppliers (EPCos or PPSs). Their contracts set unregulated rates that are determined by negotiation between customer and supplier based on their planned and actual usage (including scale, form, and period of use and load characteristics). With deregulation of the retail market in April 2016, retail customers, too, have greater choice than before. In addition to simply continuing on with the "regulated rate" plans still provided by the EPCos, they can also choose from among "unregulated rate" plans offered by both the EPCos and the PPSs (Figure 6.4).

The former general electric utilities have started to provide new rate schedules better suited to customers' lifestyles in accordance with their own business strategies. Some EPCos offer rate discount plans by bundling products in collaboration with other providers, such as gas and telecommunications companies. Many PPSs, on the other hand, offer rate schedules that give heavy users larger discounts than the regulated rates offered by their EPCo counterparts, or else provide discount plans that bundle electricity with gas or telecommunications services.

The unregulated rate plans of both the former general electric utilities and PPSs have grown more diverse since full deregulation of the retail market. Despite some regional variation, a greater diversity of unit rates and customer options are now being offered by utilities of all descriptions, ranging from rates on a par with those offered under the ordinary residential plans traditionally offered by the former general electric utilities to rates that reflect individual companies' customer strategies.

(4) Wheeling Charges

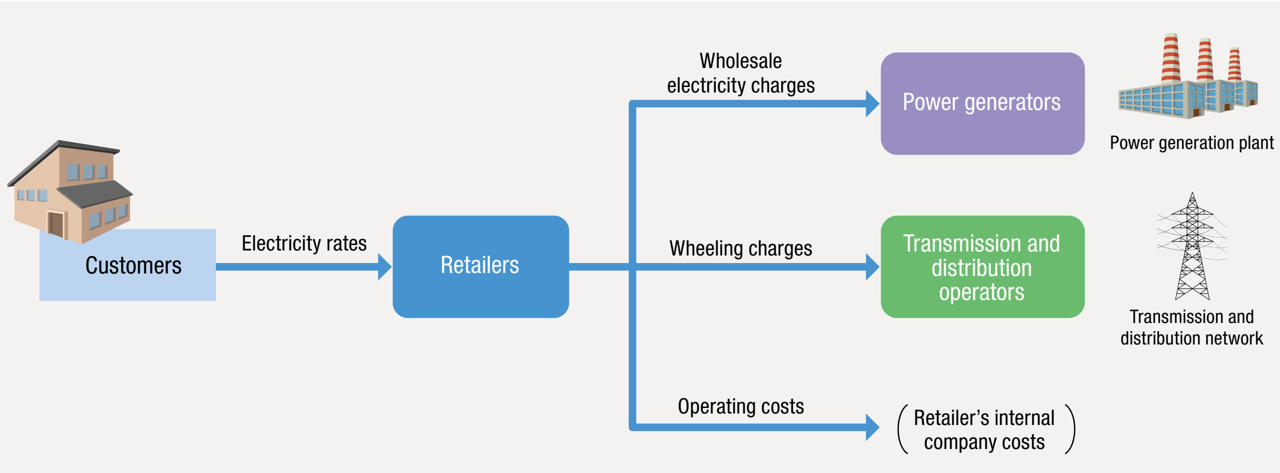
Even in a deregulated environment, it is the transmission and distribution sector that builds and maintains transmission and distribution networks to ensure stable supply. When PPSs retail electricity and general electric utilities supply electricity on a retail basis outside of their own service areas, they must use the network of the regional electricity network operator that owns the supply facilities in the service area concerned. Wheeling charges are the fees imposed by transmission and distribution operators on the users of their network. Like regulated rates, wheeling charges are calculated using the fully distributed cost method of determining the charge based on the sum of necessary costs plus an appropriate return.

Wheeling charges are calculated according to use by first breaking down regional electricity network operators' total costs into generation costs, transmission, transformation, and distribution costs, and sales costs, etc., and then allocating these transmission, transformation, and distribution-related costs to expenses according to use (extra-high voltage, high voltage, and low voltage).

The regional electricity network operator in the supply area concerned sets "wheeling provisions" stipulating the charges and terms and conditions for wheeling, in order to ensure fair competition between all the users of its network. These provisions are then submitted to the Minister of Economy, Trade and Industry. The wheeling charges are deliberated by a review meeting of specialists on electricity pricing under the auspices of the Electricity and Gas Market Surveillance Commission, taking into account both the appropriate recovery of requisite costs and fairness for network users. They are then, opened to public comment prior to final adoption.

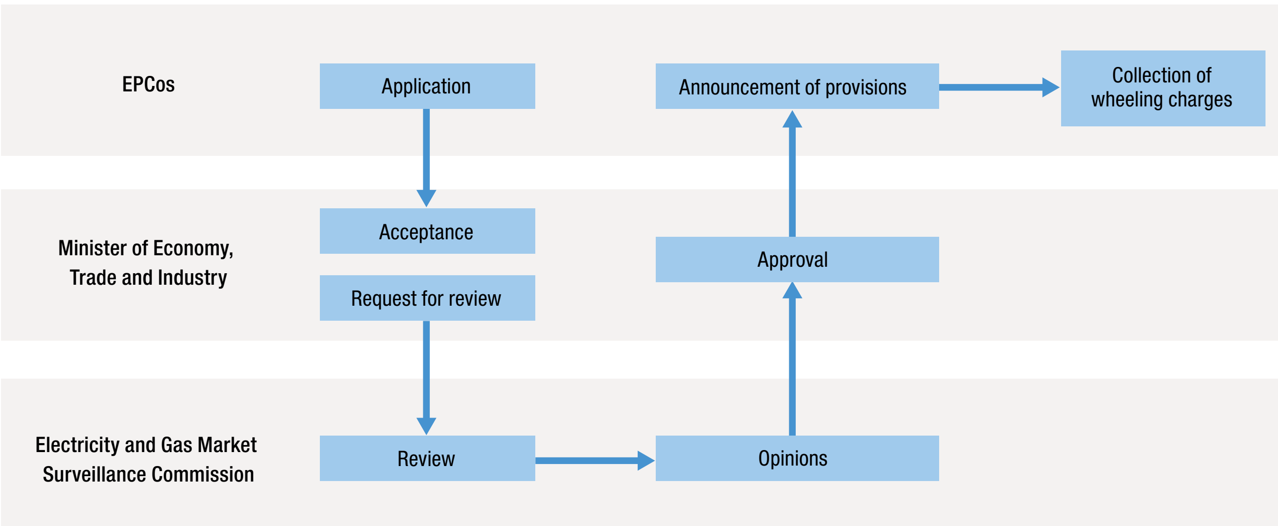
Since April 2016, regional electricity network

Figure 6.5 Position of Wheeling Charges in Electricity Rates



Source: Agency for Natural Resources and Energy, METI

Figure 6.6 Authorization Process for Wheeling Charges



Source: Agency for Natural Resources and Energy website. Includes amendments.

operators have been under obligation to provide electricity via a universal service for customers on isolated islands, applying the same rate levels as on the mainland in order to protect customers. The requisite costs for the provision of a universal service for the islands are passed on to all the customers of the regional electricity network operator in the service area in question via wheeling charges. The electricity delivered to island customers is primarily thermal in nature, and a "Universal Island Service Price Adjustment System" has been introduced to reflect any price variations affecting fuel costs for thermal generation in the wheeling charges.

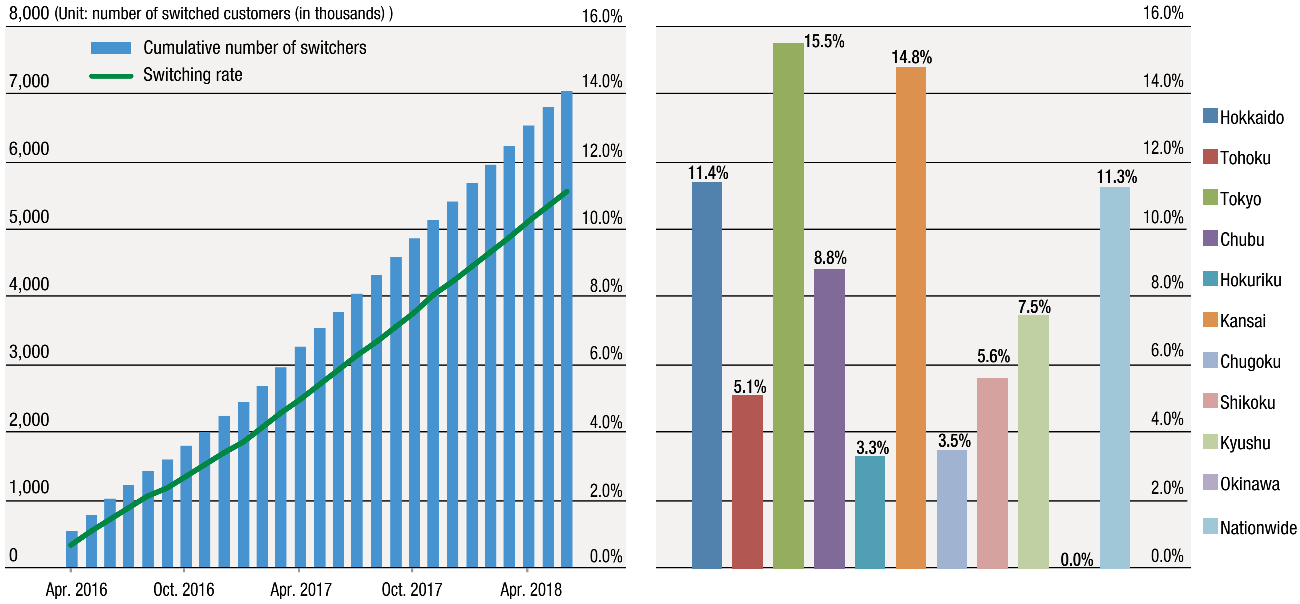
2. Efforts to Acquire Customers

(1) Customer Response

Since the full deregulation of retail electricity supplies in April 2016, all customers have been able to select the EPCo they wish to use. Switching EPCos can be used as an indicator of customer choices, especially choices by low-voltage customers.

Trends in switching by low-voltage customers are shown in Figure 6.7. In this graph, switching refers only to changing from a former general electric utility to a PPS contract. It does not include changing to an unregulated-rate contract that is offered by a former general electric utility.

Figure 6.7 **Low-Voltage Customer Switching Trends and Regional Proportions (As of End June 2018)**



Source: Compiled from power trading report data, Agency for Natural Resources and Energy, METI.

As of the end of June 2018, there had a cumulative 7.06 million cases of switching since March 2016, when switching applications were first accepted. Among general households, some 11.3% of the regular contracts in effect immediately prior to deregulation (approximately 62.53 million) had been switched. A breakdown by region shows that the proportion of switchers came to 15.5% in Tokyo EPCo's service area, 14.8% in Kansai EPCo's service area, and 11.4% in Hokkaido EPCo's service area. It is evident that while utilities in major metropolitan areas like Tokyo and Osaka have been leading the way in attracting switchers, change is underway in provincial urban areas as well.

The number of retail sector contracts held by the former general electric utilities and by PPSs are shown in Figure 6.8. Customers with contracts providing transitional rates accounted for 74.3% of the total as of the end of June 2018.

(2) Company Marketing Activities

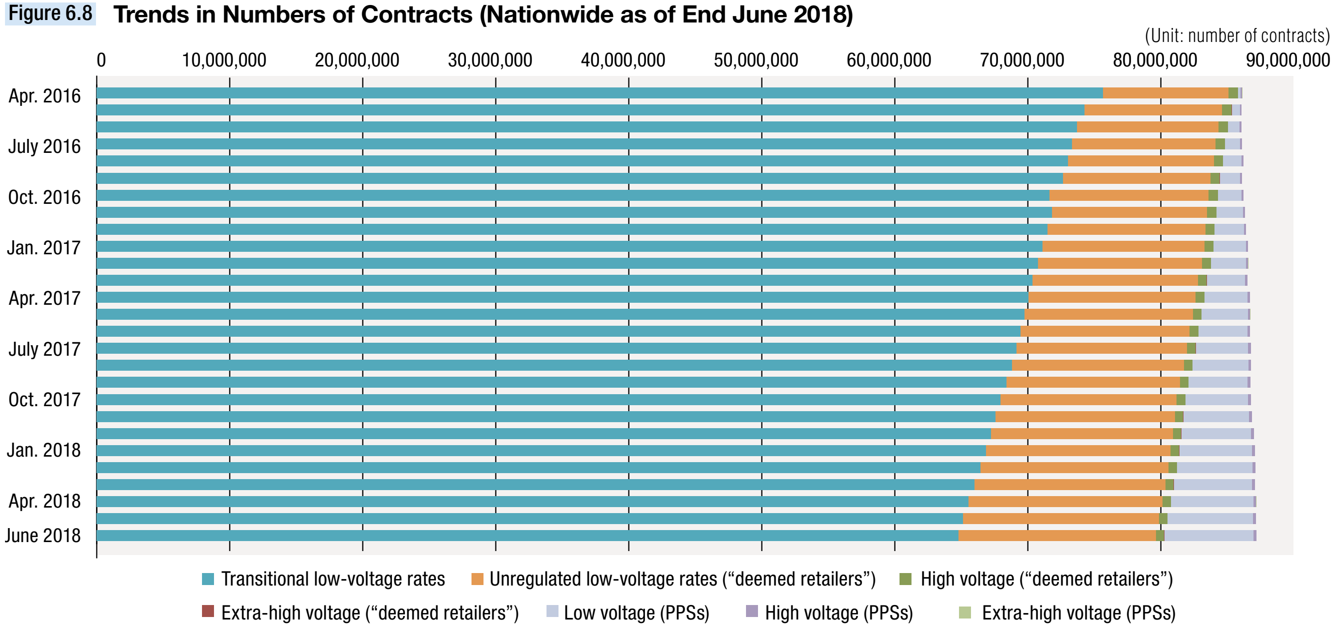
Contracts for high-voltage power (6 kV or above), which have been deregulated since before April 2016, are commonly negotiated between the supplier and each customer to decide contract details and unit prices, based on projected electricity usage and actual circumstances. The EPCos, which have traditionally served as general electric utilities for retail electricity sales, have striven to handle these kinds of customers by strengthening their business capacity, establishing specialized marketing organizations, increasing personnel to take charge of business for corporate customers, and implementing business training. For example, they have assigned a dedicated business manager for each major customer and increased the frequency of customer contact so that the customer's needs can be suitably met. In addition, they are diagnosing and analyzing the customer's energy usage, and making proactive proposals to their customers regarding the efficient use of energy in concert with their sales and technology sections.

Following the full deregulation of retail supply in April 2016, both the EPCos and PPSs have been developing attractive electricity rate schedules to entice the many customers receiving low-voltage electricity to select their services. As the following review shows, these schedules offer a range of services and discounts tailored to customer needs and lifestyles. The EPCos are also providing customer services over the internet, using the web to notify individual customers of their own electricity usage and suggesting more efficient ways to use electricity. They are also offering point-based loyalty programs to encourage customers to renew their contracts.

a. Lifestyle-matched Rate Schedule

Lifestyle-matched rate schedules are electricity rate schedules for customers who tend to be out during the day and consume most of their electricity at night, as well as for customers who use storage heaters and/or water heaters overnight and during off-peak hours. Unit

Figure 6.8 Trends in Numbers of Contracts (Nationwide as of End June 2018)



Source: Compiled from power trading report data.

prices are set differently per time of day, for example, offering lower electricity unit prices overnight.

Other schedules are also provided, including a schedule that applies discounts on the contracted unit price as usage increases for customers who use large amounts of electricity due to family size or pets, and a schedule in which electrical bills can be kept in check by establishing different rates according to the amount of electricity used simultaneously, encouraging customers to use electricity more wisely.

One supplier also offers unique discounts, such as summer-only discounts for households with one or more members aged 75 or over in order to encourage the use of air conditioning to prevent heat stroke.

b. Additional Services and Discounts for Bundled Products

There are also rate schedules that offer additional services to inspect, examine and take immediate action to prevent trouble in the customer's electrical equipment, such as a fault in the room wiring keeping the power from turning on. Some EPCos are even providing services that go beyond electricity-related issues to support the customer's daily life in general; for example, services to identify and report water leaks, find lost keys and services that can check on elderly customers at home.

There are also service plans providing discounts for bundled products including supply contracts for non-electricity-related goods and services. Examples include discount services for cellular phone and internet services, gas, automobile gasoline, and more. By bundling various lifestyle-related commodities and services together, the company benefits by pulling in the customer and improving customer retention.

c. Renewable Energy Rate Menus

Many customers are attracted to electricity rate schedules that incorporate renewable energy, and this approach to pricing is drawing strong interest. However, certain constraints remain, such as ensuring customers a steady power supply when only a limited number of companies offer such rate schedules. Furthermore, most of these companies limit access to only certain service areas.

A prerequisite for customers to be able to select their own rate schedules, including rate schedules incorporating renewable energy, is transparency and the disclosure of the offering company's actual power composition and CO_2 emissions information. Various companies are now making strong efforts in this area. Meanwhile, some of Japan's leading manufacturers are joining the "RE100" 100% renewable energy initiative, and it is possible that suppliers will develop new measures in the extra-high and high voltage sectors as well.

(3) Rate Comparison Sites

As seen above, EPCos and PPSs are offering a variety of electricity rate schedules, and there are now more than 1,000 types to choose from. Rate comparison sites have therefore been launched to help customers choose the schedules that best meet their needs. The number of companies operating per region and the number of electricity rate schedules they offer are as shown in Table 6.3. In addition to active competition in Japan's major urban centers of Tokyo, Osaka, and Nagoya, there are signs as well of growing competition in provincial urban areas in regions such as Hokkaido and Kyushu.

Table 6.3 **Number of Selectable Companies and Number of Electricity Rate Schedules Offered (As of End September 2018)**

Region	No. of selectable companies	Number of rate schedules
Hokkaido	22	73
Tohoku	26	82
Kanto, Koshin'etsu (Tokyo EPCo area)	62	254
Chubu (includes Nagoya)	35	104
Hokuriku	14	39
Kansai, Kinki (includes Osaka)	38	119
Chugoku	25	65
Shikoku	22	60
Kyushu	31	98
Okinawa	2	8

Note: Aggregated number of companies and electricity rate schedules per region. As the same company and the same plan are counted in multiple regions, the numbers in the chart are higher than in the main text.
Source: Enechange website.

(4) Regulations and Guidelines

As previously mentioned, companies are competing to acquire customers, and competition has become particularly intense in major metropolitan areas. Measures are now being taken from a consumer protection perspective to ensure that excessive marketing efforts do not put customers at a disadvantage.

To address this concern, in January 2016 the Electricity and Gas Market Surveillance Commission, established to encourage competition in the market, enacted the Guidelines Concerning the Management of the Electricity Retail Business to ensure that customer selections are made appropriately. These guidelines provide instructions to the companies in question, such as retail suppliers, on how to observe relevant laws and regulations, as well as instructions encouraging their autonomous efforts on compliance. It is hoped that these guidelines will enhance protection for electricity customers, allowing them to receive electricity with confidence while also contributing to the healthy growth of the electricity business itself.

Specifically, the guidelines indicate desirable conduct by operators in order to protect consumers and bring about the healthy growth of Japan's electricity business. These include: (1) provision of appropriate information to customers, (2) suitable forms of business and contracts, (3) optimized contract contents, (4) appropriate response to customer complaints and inquiries, and (5) optimized contract cancellation procedures. The guidelines also specify behavior which would constitute a problem under the Electricity Business Act (i.e., actions that could lead to the issuance of a business improvement order or a business improvement recommendation).

These guidelines are to be revised as and when necessitated by future changes in the electricity retail environment. Two revisions (in June 2017 and September 2018) have already been made so far.

VII. INTERNATIONAL COOPERATION AND EXCHANGE

1. Efforts by Japan's Electric Utilities to Address International Issues

Japan's electric utilities participate in international conferences with the electric power industry utilities of other countries on a regular basis to exchange views on current conditions and common challenges facing the electric utility industry worldwide and other issues. One of these conferences is the International Electricity Summit, which brings together management representatives from the electric power utilities of Japan (FEPC: The Federation of Electric Power Companies of Japan), the United States (EEI: Edison Electric Institute) and Europe (EURELECTRIC: Union of the Electricity Industry). Another is the Meeting of the General Planning Managers of the Southeast and Northeast Asian Electric Utilities, whose membership comprises the electric power utilities of the 10 ASEAN countries and three countries in Northeast Asia. These conferences provide opportunities for lively, meaningful discussions on issues confronting the world's electric utility industry.

The Japanese electric utilities are actively engaged in ongoing efforts to deal with the issue of climate change, motivated by an awareness of global warming as an issue that must be combated on a global scale over the long term with the entire business community taking part, and a recognition that it is essential for electric utilities to cooperate in these efforts with a view to simultaneously satisfying environmental and economic requirements.

Further, in October 2008, the FEPC joined its counterpart federations of electric utilities in Europe and the United States in establishing the International Electricity Partnership (IEP). The IEP provides a forum for exchanging views and the joint dissemination of shared information on matters of common concern to the electricity sectors in the various member countries, including creation of a technology roadmap for the global electric power industry. In December 2009, the IEP held a workshop at the United Nations Framework Convention on Climate Change (COP15) in Copenhagen, Denmark, where it announced the "Roadmap for a Low-Carbon Power Sector by 2050." The roadmap both presents prospects for dissemination of technologies in advanced countries and provides guidelines for technology provision and support in developing countries.

In April 2013, the International Electricity Summit (IES) was held in San Diego. The summit was attended by electricity industry organizations from around the world, including the Canadian Electricity Association and the Energy Supply Association of Australia as well as the FEPC, EEI, and EURELECTRIC. Topics discussed included fuel choice, energy efficiency, the role of distributed generation, smart grids, and strategies to work on climate change. The attending world leaders announced that discussions concerning international climate change would be continued under the framework of the IEP.

Another international organization, the Asia-Pacific Partnership on Clean Development and Climate (APP), was launched in January 2006 at the initiative of the United States with a membership comprising Japan, the United States, Australia, China, India, South Korea and, soon thereafter, Canada, which became an official member in October 2007. The APP's objective was to find appropriate means of dealing with such issues as environmental pollution, energy security and climate change, while at the same time responding to growing energy demand in the Asia-Pacific region. Japan's electric utilities participated actively in these efforts, including implementation of peer reviews (good practice sharing through exchanges among engineers) aimed at maintaining and improving the thermal efficiency of the member countries' existing coal-fired thermal power plants. Since the disbanding of APP in April 2011, these activities have been continued by its successor organization, the Global Superior Energy Performance Partnership (GSEP). Working in collaboration with electric utilities in other countries and regions, and cooperating with public and private entities in a sector-based approach, the GSEP is vigorously promoting realization of a lower-carbon, energy-saving global society by encouraging the development and introduction of technologies.

In the field of nuclear power, nine EPCos, the Japan Atomic Power Company (JAPC) and the Electric Power Development Company (J-POWER) engage proactively in communication and information exchange with nuclear power operators around the world as members of the World Association of Nuclear Operators (WANO), an organization established to increase the safety and reliability of nuclear power plants.

Explaining how to assemble and utilize kWh electric meters to maintain the accuracy of electricity consumption measurement values in the Philippines
(Shikoku EPCo)

2. International Communication and Cooperation by Japan's Electric Utilities

Japan's electric utilities conduct various programs organized to promote mutual exchange of engineers and technical cooperation with electric power industry utilities, manufacturers and related organizations in other countries. The electric utilities accept training program participants, dispatch technical specialists and offer technical guidance concerning such issues as environmental preservation measures, power-generation efficiency enhancement and energy conservation technologies.

In addition to the above, individual electric utilities also conduct independent international cooperation activities, accepting training program participants from and dispatching specialists to electric power companies, research institutes and other organizations in various countries. They also participate in international cooperation programs through organizations such as the Japan International Cooperation Agency (JICA), an independent administrative institution.

3. Other International Activities Undertaken by Japan's Electric Utilities

Some of Japan's electric utilities have capitalized on their technologies and know-how to establish overseas operations with the dual aim of contributing to a stable electric power supply and GHG reduction in their partner countries and increasing their own revenues. They are currently engaged in investment and consulting activities in Asia and other regions.

Operating and Financial Data

Operating Data

Financial Data

Operating Data

Company Data (As of March 31, 2018)

Company	Capital Stock** (Million yen)	Electricity Sales for the Year* (GWh) Residential	Commercial & Industrial	High Voltage and Extra-High Voltage	Total	Revenues from Energy Sales for the Year* (Million yen)	Installed Generating Capacity** (MW)	Employees
Hokkaido EPCo	114,291	10,828	2,448	13,463	26,739	676,649	7,957	5,642
Tohoku EPCo	251,441	23,872	3,537	46,570	73,979	1,729,716	18,209	12,316
TEPCO Power Grid	80,000	0	33	221	254	1,657,976	53	****41,525
TEPCO Energy Partner	10,000	86,380	9,324	145,822	241,525	4,989,464	***67,541	
Chubu EPCo	430,777	33,276	5,498	83,048	121,821	2,343,597	33,138	16,461
Hokuriku EPCo	117,641	8,232	1,157	18,714	28,103	496,612	8,074	5,229
Kansai EPCo	489,320	43,689	5,224	72,586	121,500	2,569,487	36,578	20,848
Chugoku EPCo	185,527	18,120	2,135	36,885	57,140	1,100,731	11,536	9,169
Shikoku EPCo	145,551	9,081	1,552	15,064	25,697	603,433	6,342	4,594
Kyushu EPCo	237,304	28,065	4,775	44,827	77,666	1,685,082	19,221	13,022
Okinawa EPCo	7,586	2,821	1,506	2,814	7,141	170,834	2,166	1,535
Subtotal	2,069,438	264,364	37,189	480,014	781,565	18,023,581	210,815	130,341
J-POWER	180,502						16,960	2,407
JAPC	120,000						2,260	1,169
Others							44,484	
Total	2,369,940	264,364	37,189	480,014	781,565	18,023,581	274,519	133,917

*Figures are for fiscal 2016. **As of March 31, 2017. ***Figures are for Tokyo Electric Power Company Holdings and TEPCO Fuel & Power. ****On a consolidated basis.
Source: METI, 10 EPCos, J-Power, JAPC

Electric Power Generation

(TWh)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Thermal*	**839.0**	**798.9**	**742.5**	**771.3**	**906.9**	**986.8**	**987.3**	**955.3**	**908.8**	**877.2**
Electric Utilities	661.0	621.3	568.4	553.3	678.5	735.9	743.1	717.8	675.7	794.7
Industry-owned	180.2	177.6	174.1	218.0	228.4	250.8	244.2	237.6	233.1	82.5
Nuclear	**263.8**	**258.1**	**279.8**	**288.2**	**101.8**	**15.9**	**9.3**	–	**9.4**	**17.3**
Electric Utilities	263.8	258.1	279.8	288.2	101.8	15.9	9.3	–	9.4	17.3
Industry-owned	–	–	–	–	–	–	–	–	–	–
Hydroelectric	**84.2**	**83.5**	**83.9**	**90.7**	**91.7**	**83.7**	**84.9**	**86.9**	**91.4**	**84.5**
Electric Utilities	76.8	75.9	74.5	74.2	74.4	67.4	68.6	70.3	74.9	81.9
Industry-owned	7.3	7.6	9.3	16.5	17.3	16.3	16.3	16.7	16.5	2.7
Wind Power	**2.6**	**2.9**	**3.6**	**4.0**	**4.7**	**4.8**	**5.2**	**5.0**	**5.2**	**5.5**
Electric Utilities	*0.0	*0.0	*0.0	*0.0	0.2	0.2	0.2	*0.0	0.1	5.0
Industry-owned	2.6	2.9	3.6	3.9	4.5	4.7	5.0	5.0	5.1	0.5
Solar Cell	***0.0**	***0.0**	***0.0**	***0.0**	***0.0**	**0.2**	**1.2**	**3.8**	**6.8**	**11.1**
Electric Utilities	*0.0	*0.0	*0.0	*0.0	*0.0	0.1	0.1	0.1	0.1	6.5
Industry-owned	*0.0	*0.0	*0.0	*0.0	*0.0	0.1	1.1	3.7	6.7	4.6
Geothermal	**3.0**	**2.8**	**2.9**	**2.6**	**2.7**	**2.6**	**2.6**	**2.6**	**2.6**	**2.2**
Electric Utilities	2.8	2.6	2.7	2.4	2.5	2.5	2.4	2.4	2.4	2.2
Industry-owned	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1
Fuel Cell	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**	****0.0**
Electric Utilities	–	–	–	–	–	–	–	–	–	–
Industry-owned	**0.0	**0.0	**0.0	**0.0	**0.0	**0.0	**0.0	**0.0	**0.0	**0.0
Others	–	–	–	–	–	–	–	–	–	**0.3**
Electric Utilities	–	–	–	–	–	–	–	–	–	0.3
Industry-owned	–	–	–	–	–	–	–	–	–	–
Total	1,195.0	1,146.3	1,112.6	1,156.9	1,107.8	1,094.0	1,090.5	1,053.7	1,024.2	998.1
Electric Utilities	1,004.6	957.9	925.4	918.2	857.4	822.0	823.7	790.6	762.6	907.9
Industry-owned	190.4	188.4	187.2	238.7	250.4	272.0	266.8	263.1	261.6	90.2

*Including biomass- and waste-to-energy power plants.
**Less than a unit
Source: METI

Electric Power Consumption

(TWh)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015
Residential	289.7	285.3	285.0	304.2	289.0	286.2	284.3	273.1	266.9
Commercial and Industrial	49.7	46.8	45.2	47.5	44.9	43.7	42.8	40.5	39.2
Deregulated Customers	595.6	571.7	544.0	574.9	545.6	541.0	544.4	537.8	531.5
Customers in Designated Service Districts	16.8	12.1	9.9	0.0	0.0	0.0	0.0	0.0	0.0
Consumption of Power for Station Operation	7.8	9.6	12.6	4.4	4.3	4.4	4.5	3.9	4.0
Supplied by Electric Utilities	959.7	925.5	896.7	931.1	883.8	875.3	876.0	855.4	841.5
Consumption of Independently Generated Power	117.8	110.0	106.2	125.4	118.7	116.3	116.6	114.1	113.7
Total Consumption	1,077.5	1,035.5	1,002.8	1,056.4	1,002.4	991.6	992.6	969.4	955.2

FY	2016
Residential	271.8
Commercial and Industrial	37.6
High Voltage	307.4
Extra-High Voltage	231.4
Specified Supply	3.4
Others (Last-Resort Service and Supply to Isolated Islands)	2.3
Self-Consumption	45.8
Supplied by Electric Utilities	899.8
Self-Consumption of Independently Generated Power	63.4
Total Consumption	963.1

Source: METI

Electric Power Demand (Deemed Retailers, Etc.)

(TWh)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015
Customers in Regulated Fields	339.5	332.0	330.1	351.7	333.9	329.9	327.1	313.6	306.0
Residential	289.7	285.3	285.0	304.2	288.9	286.2	284.3	273.1	266.9
Commercial and Industrial	49.7	46.8	45.1	47.5	44.9	43.7	42.8	40.5	39.1
Deregulated Customers	580.1	556.9	528.4	554.7	525.9	521.7	521.4	509.4	491.1
Total	919.5	888.9	858.5	906.4	859.8	851.6	848.5	823.0	797.1

FY	2016
Low Voltage	301.6
Residential	264.3
Commercial and Industrial	37.2
High Voltage	262.3
Extra-High Voltage	217.7
Others (Last-Resort Service and Supply to Isolated Islands)	2.3
Total	783.8

Source: FEPC (2007-2015), METI (2016)

Number of Customers by Type of Contract (10 EPCos)

(1,000 customers)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Residential	74,772	75,240	75,629	75,765	76,320	76,785	77,372	77,950	78,567	65,612
Commercial and Industrial	8,212	8,044	7,885	7,714	7,571	7,419	7,291	7,184	7,087	4,784
Total	82,983	83,284	83,514	83,479	83,891	84,204	84,663	85,134	85,654	70,396

Note: All figures exclude demand in deregulated fields.
Source: FEPC (2007-2011), METI (2012-2016)

Power Consumption by Sector of Industry

(TWh)

FY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mining	1.0	0.9	0.9	0.8	0.9	0.9	0.9	0.9	1.0	0.9
Foodstuffs	16.1	17.2	17.3	17.2	17.7	17.4	17.5	17.9	17.8	17.9
Textiles	3.2	3.2	2.8	4.0	4.5	4.3	4.0	4.0	4.0	3.8
Pulp and Paper	10.5	11.0	10.6	9.4	9.9	9.2	8.5	8.5	8.1	7.5
Chemicals	29.3	31.3	29.4	26.1	27.9	27.0	26.2	26.4	26.1	25.3
Oil and Coal Products	1.6	1.7	1.9	1.8	2.1	2.1	2.2	2.2	2.3	2.2
Rubber	3.3	3.3	3.1	2.8	3.1	3.0	2.9	2.9	2.9	2.7
Clay and Stone	11.8	12.1	11.4	10.3	11.5	11.5	11.1	10.7	10.4	9.9
Iron and Steel	38.9	39.6	35.4	29.7	36.3	36.4	35.9	37.3	36.6	34.1
Nonferrous Metals	15.1	16.8	15.7	14.7	16.0	15.7	15.1	14.3	14.6	14.4
Machinery	78.6	82.6	75.7	69.0	74.0	71.1	68.5	68.8	68.5	67.3
Other Manufacturing	29.3	30.5	28.7	27.4	29.0	27.9	27.1	27.5	26.8	25.9
Railways	18.7	18.7	18.7	18.1	18.1	17.2	17.3	17.3	17.1	17.2
Others	29.7	30.3	30.0	29.6	29.4	27.9	28.0	27.8	27.1	26.7
Total	287.2	299.3	281.6	260.9	280.4	271.5	265.1	266.5	263.2	255.9

Note: "Industrial" refers to customers with a contracted demand of 500kW or above.
Source: FEPC

Installed Generating Capacity* (MW)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Thermal**	**176,412**	**179,324**	**181,736**	**182,381**	**185,309**	**188,903**	**191,258**	**193,356**	**190,805**	**193,910**
Electric Utilities	138,127	140,023	142,574	135,070	136,132	139,794	141,901	143,777	143,040	174,392
Industry-owned	38,285	39,302	39,162	47,312	49,177	49,109	49,357	49,579	47,765	19,517
Nuclear	**49,467**	**47,935**	**48,847**	**48,960**	**48,960**	**46,148**	**44,264**	**44,264**	**42,048**	**41,482**
Electric Utilities	49,467	47,935	48,847	48,960	48,960	46,148	44,264	44,264	42,048	41,482
Industry-owned	–	–	–	–	–	–	–	–	–	–
Hydroelectric	**47,637**	**47,949**	**47,966**	**48,111**	**48,419**	**48,934**	**48,932**	**49,597**	**50,035**	**50,058**
Electric Utilities	45,977	46,252	45,221	43,849	44,168	44,651	44,676	45,403	45,786	49,521
Industry-owned	1,660	1,697	2,745	4,262	4,250	4,282	4,256	4,194	4,248	536
Wind Power	**1,527**	**1,756**	**1,997**	**2,294**	**2,419**	**2,562**	**2,646**	**2,750**	**2,808**	**3,203**
Electric Utilities	4	4	12	85	85	83	82	30	50	2,893
Industry-owned	1,523	1,752	1,985	2,209	2,334	2,479	2,563	2,720	2,758	310
Solar	**10**	**13**	**16**	**32**	**85**	**267**	**1,559**	**4,085**	**5,624**	**9,110**
Electric Utilities	0	0	0	13	61	65	67	81	87	5,655
Industry-owned	10	13	16	19	24	202	1,492	4,005	5,536	3,455
Geothermal	**532**	**532**	**535**	**537**	**537**	**512**	**512**	**508**	**517**	**526**
Electric Utilities	497	497	500	502	502	477	477	473	473	511
Industry-owned	35	35	35	35	35	35	35	35	43	15
Others	**3**	**1**	**1**	–	–	–	–	–	–	**64**
Electric Utilities	–	–	–	–	–	–	–	–	–	64
Industry-owned	3	1	1	–	–	–	–	–	–	0
Total	275,588	277,511	281,099	282,315	285,729	287,327	289,171	294,560	291,836	298,352
Electric Utilities	234,073	234,711	237,153	228,479	229,908	231,219	231,468	234,028	231,484	274,519
Industry-owned	41,516	42,800	43,946	53,836	55,821	56,107	57,703	60,532	60,352	23,834

*Figures for industry-owned generation represent the total amount generated by power plants with a generating capacity of 1,000kW or above.
**Including biomass- and waste-to-energy power plants.
Source: FEPC (2007-2015), METI (2016)

Installed Generating Capacity and Electric Power Generation by Electric Utilities (As of March, 2017)

Company	Thermal*		Nuclear		Hydroelectric		Wind		Solar		Geothermal		Others		Total	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Hokkaido EPCo	4,214	19,297	2,070	–	1,648	3,794	–	–	1	1	25	104	–	–	7,957	23,196
Tohoku EPCo	12,265	54,128	3,274	–	2,441	6,885	–	–	5	5	224	783	–	–	18,209	61,801
Tokyo EPCo**	45,060	190,276	12,612	–	9,871	10,034	18	24	30	33	3	10	–	–	67,594	200,378
Chubu EPCo	24,034	110,217	3,617	–	5,450	8,573	22	24	15	19	–	–	–	–	33,138	118,832
Hokuriku EPCo	4,400	22,010	1,746	–	1,924	5,746	–	1	4	4	–	–	–	–	8,074	27,760
Kansai EPCo	19,413	81,606	8,928	–	8,226	13,362	–	0	11	11	–	–	–	–	36,578	94,978
Chugoku EPCo	7,801	33,943	820	–	2,910	3,833	–	–	6	8	–	–	–	–	11,536	37,783
Shikoku EPCo	3,736	13,274	1,456	4,717	1,147	2,222	–	–	2	2	–	–	–	–	6,342	20,216
Kyusyu EPCo	10,730	45,615	4,699	12,584	3,580	4,787	3	2	3	4	206	1,128	–	–	19,221	64,119
Okinawa EPCo	2,164	6,490	–	–	–	–	2	2	–	–	–	–	–	–	2,166	6,492
Subtotal	133,817	576,856	39,222	17,301	37,197	59,236	46	53	76	87	458	2,025	–	–	210,815	655,558
J-POWER	8,374	51,651	–	–	8,571	9,304	–	–	–	–	15	15	–	–	16,960	60,971
JAPC	–	–	2,260	–	–	–	–	–	–	–	–	–	–	–	2,260	–
Others	32,201	166,228	–	–	3,753	13,329	2,847	4,947	5,579	6,436	38	–	64	269	44,484	191,324
Total	174,392	794,735	41,482	17,301	49,521	81,870	2,893	5,000	5,655	6,522	511	2,158	64	269	274,519	907,853

*Including biomass- and waste-to-energy power plants.
**Total for Tokyo Electric Power Company Holdings, TEPCO Fuel & Power, and TEPCO Power Grid.
Source: METI

Fossil Fuel Consumed for Power Generation by Electric Utilities

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Heavy Oil (thousand kl)	14,239	12,566	721	6,318	11,846	16,090	12,697	9,434	7,095	8,236	6,339
Crude Oil (thousand kl)	11,301	7,978	3,643	4,759	11,567	13,477	11,576	6,758	5,700	2,789	1,587
Naphtha (thousand kl)	–	–	–	–	–	–	–	–	–	–	–
LNG (thousand t)	42,105	41,034	40,671	41,743	52,870	55,709	56,092	56,610	52,306	55,688	52,922
Coal* (thousand t)	84,205	80,992	76,805	72,153	69,934	71,084	80,884	80,230	80,285	110,859	114,997
Total (thousand kl heavy oil equivalent)**	140,503	131,112	118,577	113,573	139,925	151,676	151,993	145,334	136,190	–	–

*Coal refers to wet coal.
**Total includes small amounts of NGL, gas oil, LPG, natural gas and other gases.
***The total amount is not available after 2016.
Source: FEPC (2007-2015), METI (2016-2017)

Transmission, Transformation and Distribution Facilities of the EPCos (As of March 31, 2017)

	Transmission Lines (km)				Transformers	
	Route length		Circuit length			
Voltage (kV)	Overhead	Underground	Overhead	Underground	Number	Maximum Output (MVA)
500	7,811	89	15,237	177	83	224,050
275	7,428	607	14,694	1,519	158	173,375
220	2,684	61	5,085	133	62	38,960
187	2,735	15	5,229	35	39	16,735
110–154	15,515	998	28,252	1,920	681	155,600
66–77	38,175	7,290	68,351	13,190	4,468	223,645
<55	13,351	6,122	14,596	10,101	1,275	9,718

Distribution Lines (thousand km)				Distribution Transformers	
Route length*		Circuit length		Maximum Output [MVA]	
Overhead	Underground	Overhead	Underground	Overhead	Underground
945,627	42,839	4,015,703	71,360	331,212	34,106

*Distribution route length indicates actual length.
Source: METI

Network Loss, Total Loss and Thermal Efficiency (10 EPCos)

FY	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Network Loss (%)	4.9	5.1	5.2	4.8	5.0	4.7	5.0	4.9	4.7	4.7
Total Loss (%)	8.4	8.5	8.6	8.2	8.3	7.8	8.1	7.9	7.8	–
Thermal Efficiency (Gross, %)*	41.01	41.35	41.78	41.86	41.74	41.81	42.20	42.80	42.93	–

*Principal Thermal Power Plants Owned by Electric Utilities.
Source: FEPC (2007-2015), METI (2016)

Principal Thermal Power Plants Owned by Electric Utilities (1,500 MW or Above) (As of March 31, 2017)

Name of Plant (A-Z)	Company	Installed Capacity (MW)	Unit Capacity (MW) × No. of Units	Fuel	Year Commissioned
Akita	Tohoku EPCo	1,633	350 × 2	Heavy, crude oil	1972-74
			600 × 1	Heavy, crude oil	1980
			333 × 1	Light oil (Gas turbine)	2012
Anegasaki	Tokyo EPCo (F&P)*	3,600	600 × 2	LNG, heavy, crude oil	1967-69
			600 × 2	LNG, LPG, heavy, crude oil	1971-72
			600 × 2	LNG, LPG	1977-79
Atsumi	Chubu EPCo*	1,900	500 × 1**	Heavy, crude oil	1971
			700 × 2	Heavy, crude oil	1981
Chiba	Tokyo EPCo (F&P)*	4,380	1,440 × 2	LNG (Combined-cycle)	2000
			1,500 × 1	LNG (Combined-cycle)	2014
Chita	Chubu EPCo*	3,966	375 × 2	LNG	1966-67
			500 × 1	LNG	1968
			700 × 1	LNG	1974
			700 × 2	LNG	1978
			154 × 4	LNG (Gas turbine)	1994-96
Chita No. 2	Chubu EPCo*	1,708	700 × 2	LNG	1983
			154 × 2	LNG (Gas turbine)	1994-96
Futtsu	Tokyo EPCo (F&P)*	5,040	1,000 × 2	LNG (Combined-cycle)	1986-88
			1,520 × 2	LNG (Combined-cycle)	2003-10
Gobo	Kansai EPCo	1,800	600 × 3	Heavy, crude oil	1984-85
Goi	Tokyo EPCo (F&P)*	1,886	265 × 4	LNG	1963-66
			350 × 2	LNG	1968
			126 × 1	LNG (Gas turbine)	1994
Haramachi	Tohoku EPCo	2,000	1,000 × 2	Coal, Biomass	1997-98
Hekinan	Chubu EPCo*	4,100	700 × 3	Coal, Biomass	1991-93
			1,000 × 2	Coal, Biomass	2001-02
Higashi Ohgishima	Tokyo EPCo (F&P)*	2,000	1,000 × 2	LNG	1987-91
Higashi-Niigata	Tohoku EPCo	5,149	600 × 2	LNG, NG, heavy, crude oil	1977-83
			1,210 × 1	LNG (Combined-cycle)	1985
			1,700 × 1	LNG (Combined-cycle)	2006
			350 × 2	LNG, heavy oil	1972-75
			339 × 1	LNG (Gas turbine)	2012
Himeji No. 1	Kansai EPCo	1,507.4	729 × 1	LNG (Combined-cycle)	1995
			713 × 1	LNG (Combined-cycle)	1996
			32.7 × 2	LNG (Gas turbine)	2012
Himeji No. 2	Kansai EPCo	4,086	481 × 6	LNG(Combined-cycle)	2013-14
			600 × 2	LNG	1973
Hirono	Tokyo EPCo (F&P)*	4,400	600 × 2	Heavy, crude oil	1980
			1,000 × 2	Heavy, crude oil	1989-93
			600 × 2	Coal	2004-13
Hitachinaka	Tokyo EPCo (F&P)*	2,000	1,000 × 2	Coal	2003-13
Joetsu	Chubu EPCo*	2,380	1,190 × 1	LNG(Combined-cycle)	2012-13
			1,190 × 1	LNG(Combined-cycle)	2013-14
Kainan	Kansai EPCo	2,100	450 × 2	Heavy, crude oil	1970
			600 × 2	Heavy, crude oil	1973-74
Kashima	Tokyo EPCo (F&P)*	5,660	600 × 4	Heavy, crude oil	1971-72
			1,000 × 2	Heavy, crude oil	1974-75
			1,260 × 1	City gas(Combined-cycle)	2014
Kawagoe	Chubu EPCo*	4,802	700 × 2	LNG	1989-90
			1,701 × 2	LNG (Combined-cycle)	1996-97
Kawasaki	Tokyo EPCo (F&P)*	3,420	1,500 × 1	LNG (Combined-cycle)	2009
			500 × 1	LNG (Combined-cycle)	2013
			710 × 2	LNG (Combined-cycle)	2016

Name of Plant (A-Z)	Company	Installed Capacity (MW)	Unit Capacity (MW) × No. of Units	Fuel	Year Commissioned
Maizuru	Kansai EPCo	1,800	900 × 2	Coal, Biomass	2004-10
Matsuura	J-POWER	2,000	1,000 × 2	Coal, Biomass	1990-97
Nakoso	Joban Joint Power Co., Ltd.	1,700	250 × 1	Coal, Biomass	1970
			600 × 1	Coal, Biomass	1983
			600 × 1	Coal, heavy oil, Biomass	1983
			250 × 1	Coal (IGCC)	2013
Nanko	Kansai EPCo	1,800	600 × 3	LNG	1990-91
Sakaiko	Kansai EPCo	2,000	400 × 5	LNG (Combined-cycle)	2009-10
Shin Kokura	Kyushu EPCo	1,800	600 × 3	LNG	1978-83
Shin Nagoya	Chubu EPCo*	3,058	1,458 × 1	LNG (Combined-cycle)	1998
			1,600 × 1	LNG (Combined-cycle)	2008
Shin Oita	Kyushu EPCo	2,804	690 × 1	LNG (Combined-cycle)	1991
			920 × 1	LNG (Combined-cycle)	1995
			735 × 1	LNG (Combined-cycle)	1998
			459 × 1	LNG (Combined-cycle)	2016
Shinchi	Soma Joint Power Co.	2,000	1,000 × 2	Coal	1994-95
Sodegaura	Tokyo EPCo (F&P)*	3,600	600 × 1	LNG	1974
			1,000 × 3	LNG	1975-79
Tachibanawan	J-POWER	2,100	1,050 × 2	Coal	2000
Tomatou-Atsuma	Hokkaido EPCo	1,650	350 × 1	Coal	1980
			600 × 1	Coal	1985
			700 × 1	Coal	2002
Toyama Shinko	Hokuriku EPCo	1,500	500 × 2	Heavy, crude oil	1974-81
			250 × 2	Coal, heavy oil	1971-72
Yokohama	Tokyo EPCo (F&P)*	3,460	175 × 1	LNG, heavy, crude oil	1964
			350 × 1	LNG, heavy, crude oil	1968
			1,481 × 1***	LNG (Combined-cycle)	1998
			1,454 × 1***	LNG (Combined-cycle)	1998

*Tokyo EPCo (F&P) and Chubu EPCo thermal power plants transferred to JERA effective April 1, 2019.
**Unit 1 closed down effective December 26, 2017.
***Improvement work completed in December 2017. Present output 1,508MW.
Note: Plants are listed in alphabetic order.
"Year Commissioned" refers to the date operation began with the installed capacity indicated in the chart.
Source: METI

Under Planning, Under Construction (400MW or Above) (As of March 31, 2017)

Name of Plant	Company	Fuel	Unit Capacity (MW)	Planned Start of Operation
Ishikariwan Shinko Unit1	Hokkaido EPCo	LNG (Combined-cycle)	569.4	2019
Ishikariwan Shinko Unit2	Hokkaido EPCo	LNG (Combined-cycle)	569.4	2026
Ishikariwan Shinko Unit3	Hokkaido EPCo	LNG (Combined-cycle)	569.4	2030
Noshiro Unit3	Tohoku EPCo	Coal (USC)	600	2020
Joetsu Unit1	Tohoku EPCo	LNG (Combined-cycle)	572	2023
Nishi Nagoya Unit7-1T*	Chubu EPCo**	LNG (Combined-cycle)	1,188.2	2017
Nishi Nagoya Unit7-2T*	Chubu EPCo**	LNG (Combined-cycle)	1,188.2	2018
Taketoyo Unit5	Chubu EPCo**	Coal (USC)	1,070	2022
Toyama Shinko LNG #1***	Hokuriku EPCo	LNG (Combined-cycle)	424.7	2018
Wakayama	Kansai EPCo	LNG	3,700	From fiscal 2027 onward
Misumi #2	Chugoku EPCo	Coal (USC)	1,000	2022
Saijo #1 (Replace)	Shikoku EPCo	Coal (USC)	500 (+344)	2023
Matsuura Unit2	Kyushu EPCo	Coal (USC)	1,000	2019
Takehara Unit1	J-POWER	Coal (USC)	600	2020
Hitachinaka Generation	JERA	Coal (USC)	650	2020
Goi	JERA	LNG (Combined-cycle)	780 × 3	2023
Anegasaki	JERA	LNG (Combined-cycle)	650 × 3	2023
Yokosuka	JERA	Coal (USC)	650 × 2	2023

*All units of Nishi Nagoya Thermal Power Station went into operation on March 30, 2018.
**Tokyo EPCo (F&P) and Chubu EPCo thermal power plants transferred to JERA effective April 1, 2019.
***Toyama Shinko Thermal Power Station #1 went into operation on November, 2018.
Source: 10 EPCos, J-POWER

Renewable Energy (1,000kW or Above) (As of March 31, 2017)

Name of Plant	Unit Number	Company	Installed Capacity (MW)	Generation Type	Year Commissioned
Date Solar		Hokkaido EPCo	1.0	Solar	2011
Fukuyama		Chugoku EPCo	3.0	Solar	2011
Hachinohe		Tohoku EPCo	1.5	Solar	2011
Haramachi		Tohoku EPCo	1.0	Solar	2015
Komekurayama		Tokyo EPCo HD	10.0	Solar	2012
Matsuyama		Shikoku EPCo	2.0	Solar	2010
Mega Solar Iida		Chubu EPCo	1.0	Solar	2011
Mega Solar Omuta		Kyushu EPCo	3.0	Solar	2010
Mega Solar Shimizu		Chubu EPCo	8.0	Solar	2015
Mikuni		Hokuriku EPCo	1.0	Solar	2012
Ohgishima		Tokyo EPCo HD	13.0	Solar	2011
Sakai		Kansai EPCo	10.0	Solar	2011
Sendai		Tohoku EPCo	2.0	Solar	2012
Shika		Hokuriku EPCo	1.0	Solar	2011
Suzu		Hokuriku EPCo	1.0	Solar	2012
Toyama		Hokuriku EPCo	1.0	Solar	2011
Ube		Chugoku EPCo	3.0	Solar	2014
Ukishima		Tokyo EPCo HD	7.0	Solar	2011
Higashi Izu	11	Tokyo EPCo PG	18.37	Onshore Wind	2015
Nomamisaki		Kyushu EPCo	3.0	Onshore Wind	2003
Omaezaki		Chubu EPCo	22.0	Onshore Wind	2010-11
Hachijojima		Tokyo EPCo PG	3.3	Geothermal	1999
Hatchoubaru	1	Kyushu EPCo	55.0	Geothermal	1977
	2	Kyushu EPCo	55.0	Geothermal	1990
Hatchoubaru Binary		Kyushu EPCo	2.0	Geothermal	2006
Kakkonda	1	Tohoku EPCo Tohoku Sustainable & Renewable Energy Co.	50.0	Geothermal	1978
	2	Tohoku EPCo Tohoku Sustainable & Renewable Energy Co.	30.0	Geothermal	1996
Matsukawa		Tohoku Sustainable & Renewable Energy Co.	23.5	Geothermal	1966
Mori		Hokkaido EPCo	25.0	Geothermal	1982
Ogiri		Kyushu EPCo Nittetsu Mining Co., Ltd.	30.0	Geothermal	1996
Onikobe		J-POWER	15.0	Geothermal	1975
Otake		Kyushu EPCo	12.5	Geothermal	1967
Sumikawa		Tohoku EPCo Mitsubishi Material Co.	50.0	Geothermal	1995
Takigami		Kyushu EPCo Idemitsu Oita Geothermal Co.	27.5	Geothermal	1996
Uenotai		Tohoku EPCo Tohoku Sustainable & Renewable Energy Co.	28.8	Geothermal	1994
Yamagawa		Kyushu EPCo	25.96	Geothermal	1995
Yanaizu-Nishiyama		Tohoku EPCo Okuaizu Geothermal Co.	65.0	Geothermal	1995

Note: Plants are listed in alphabetical order by type.
Source: METI

Nuclear Power Plants (As of March 31, 2017)

Name of Plant	Company	Installed Capacity (MW)	Unit Number	Type of Reactor	Unit Capacity (MW)	Year Commissioned
Fukushima No. 2	Tokyo EPCo	4,400	1	BWR	1,100	1982
			2	BWR	1,100	1984
			3	BWR	1,100	1985
			4	BWR	1,100	1987
Genkai	Kyushu EPCo	2,919	2	PWR	559	1981
			3	PWR	1,180	1994
			4	PWR	1,180	1997
Hamaoka	Chubu EPCo	3,617	3	BWR	1,100	1987
			4	BWR	1,137	1993
			5	ABWR	1,380	2005
Higashi-dori	Tohoku EPCo	1,100	1	BWR	1,100	2005
Ikata	Shikoku EPCo	1,456	2	PWR	566	1982
			3	PWR	890	1994
Kashiwazaki Kariwa	Tokyo EPCo	8,212	1	BWR	1,100	1985
			2	BWR	1,100	1990
			3	BWR	1,100	1993
			4	BWR	1,100	1994
			5	BWR	1,100	1990
			6	ABWR	1,356	1996
			7	ABWR	1,356	1997
Mihama	Kansai EPCo	826	3	PWR	826	1976
Ohi	Kansai EPCo	4,710	1	PWR	1,175	1979
			2	PWR	1,175	1979
			3	PWR	1,180	1991
			4	PWR	1,180	1993
Onagawa	Tohoku EPCo	2,174	1	BWR	524	1984
			2	BWR	825	1995
			3	BWR	825	2002
Sendai	Kyushu EPCo	1,780	1	PWR	890	1984
			2	PWR	890	1985
Shika	Hokuriku EPCo	1,746	1	BWR	540	1993
			2	ABWR	1,206	2006
Shimane	Chugoku EPCo	820	2	BWR	820	1989
Takahama	Kansai EPCo	3,392	1	PWR	826	1974
			2	PWR	826	1975
			3	PWR	870	1985
			4	PWR	870	1985
Tokai No. 2	JAPC	1,100		BWR	1,100	1978
Tomari	Hokkaido EPCo	2,070	1	PWR	579	1989
			2	PWR	579	1991
			3	PWR	912	2009
Tsuruga	JAPC	1,160	2	PWR	1,160	1987

Note: Plants are listed in alphabetical order.
Source: METI

Under Planning, Under Construction (As of March 31, 2017)

Name of Plant	Company	Unit Number	Type of Reactor	Unit Capacity (MW)	Planned Start of Operation
Shimane	Chugoku EPCo	3	ABWR	1,373	Undecided
Oma	J-POWER	1	ABWR	1,383	Undecided
Higashi-dori	Tokyo EPCo	1	ABWR	1,385	Undecided

Source: 10 EPCos, JAPC, J-POWER

Principal Hydroelectric Power Plants Owned by Electric Utilities (400 MW or Above) (As of March 31, 2017)

Name of Plant	Company	Type	Installed Capacity (MW)	Maximum Discharge (m^3/sec)	Effective Head (m)	Year Commissioned
Azumi	Tokyo EPCo	Pumped-storage	623	540	136	1970
Hongawa	Shikoku EPCo	Pumped-storage	615	140	528	2003
Imaichi	Tokyo EPCo	Pumped-storage	1,050	240	524	1991
Kannagawa	Tokyo EPCo	Pumped-storage	940	170	653	2012
Kazunogawa	Tokyo EPCo	Pumped-storage	1,200	210	714	2014
Kisenyama	Kansai EPCo	Pumped-storage	466	248	219	1970
Kyogoku (No. 1, No. 2)	Hokkaido EPCo	Pumped-storage	400	190.5	369	2015
Matanogawa	Chugoku EPCo	Pumped-storage	1,200	300	489	1996
Nabara	Chugoku EPCo	Pumped-storage	620	254	294	1976
Numappara	J-POWER	Pumped-storage	675	173	478	1973
Numazawa No. 2	Tohoku EPCo	Pumped-storage	460	250	214	1982
Ohira	Kyushu EPCo	Pumped-storage	500	124	490	1975
Okawachi	Kansai EPCo	Pumped-storage	1,280	382	395	1995
Okukiyotsu	J-POWER	Pumped-storage	1,000	260	470	1982
Okukiyotsu No. 2	J-POWER	Pumped-storage	600	154	470	1996
Okumino	Chubu EPCo	Pumped-storage	1,500	375	486	1995
Okutadami	J-POWER	Conventional	560	387	170	2003
Okutataragi	Kansai EPCo	Pumped-storage	1,932	594	388	1998
Okuyahagi No. 2	Chubu EPCo	Pumped-storage	780	234	404	1981
Okuyoshino	Kansai EPCo	Pumped-storage	1,206	288	505	1980
Omarugawa	Kyushu EPCo	Pumped-storage	1,200	222	646	2011
Shimogo	J-POWER	Pumped-storage	1,000	314	387	1991
Shin Takasegawa	Tokyo EPCo	Pumped-storage	1,280	644	229	1981
Shin Toyone	J-POWER	Pumped-storage	1,125	645	203	1973
Shiobara	Tokyo EPCo	Pumped-storage	900	324	338	1995
Tagokura	J-POWER	Conventional	400	420	105	2012
Tanbara	Tokyo EPCo	Pumped-storage	1,200	276	518	1986
Tenzan	Kyushu EPCo	Pumped-storage	600	140	520	1987

Notes: 1. Plants are listed in alphabetical order.
2. "Year Commissioned" refers to the date operation began with the installed capacity indicated in the chart.
Sources: METI

Under Planning, Under Construction (As of March 31, 2017)

Name of Plant	Company	Type	Expected Capacity (MW)	Maximum Discharge (m^3/sec)	Effective Head (m)	Planned Start of Operation
Kannagawa Unit No. 3-6	Tokyo EPCo*	Pumped-storage	1,880	510	653	2028-
Kazunogawa unit No.3	Tokyo EPCo*	Pumped-storage	400	280	714	2028-
Kyogoku unit No.3	Hokkaido EPCo	Pumped-storage	200	190.5	369	2028-

*Tokyo EPCo construction plants as of March 31, 2018.
Note: Plants are listed in order of the year that the first generator will commission.
Source: EPCos

Peak Capacity, Peak Load, Energy Requirement, Reserve Margin and Load Factor

FY	2009	2010	2011	2012	2013	2014	2015	2016	2017
Peak Capacity (GW)*	201.5	199.0	175.9	176.9	179.5	179.8	184.2	180.4	185.2
Peak Load (GW)*	160.8	178.9	156.4	157.2	161.6	154.3	161.2	156.2	157.1
Energy Requirement (TWh)**	941.8	974.3	926.8	914.7	917.5	898.9	888.2	887.1	892.6
Reserve (GW)***	40.7	20.1	19.5	19.7	17.9	25.6	23.0	24.2	28.1
Reserve Margin (%)***	25.3	11.2	12.5	12.6	11.1	16.6	14.3	15.5	17.9
Load Factor (%)****	66.9	62.2	67.4	66.4	64.8	66.5	62.9	64.8	64.9

*Peak capacity and peak load are for all electric utilities in Japan.
Peak capacity is the largest possible supply capacity; peak load is the average value of the three highest daily loads at the transmission end occurring during the month in which the annual peak is recorded.
** Energy requirement is the total annual demand for electric utilities in Japan.
*** Reserve = Peak Capacity — Peak Load

$$\text{Reserve Margin} = \frac{\text{Reserve} \times 100}{\text{Peak Load}}$$

$$\text{**** Load Factor} = \frac{\text{Energy Requirement} \times 100}{\text{Peak Load} \times 365\ (366) \times 24\text{hours}}$$

Source: Japan Electric Power Survey Committee (2009–2014), OCCTO (2015–2017)

Balance of Electricity Supply and Demand (Electric Utilities)

FY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electric Energy Requirement (TWh)										
At Transmission End	971.4	941.8	974.3	926.8	914.7	917.5	898.9	888.2	887.1	892.6
Total Peak Capacity	199.5	201.5	199.0	176.0	176.9	179.5	179.8	184.2	180.4	185.2
Peak Load	181.0	160.8	178.9	156.4	157.2	161.6	154.3	161.2	156.2	157.1
Reserve	18.5	40.7	20.1	19.5	19.7	17.9	25.6	23.0	24.2	28.1
Reserve Margin (%)	10.2	25.3	11.2	12.5	12.6	11.1	16.6	14.3	15.5	17.9
Total Generating Capacity										
Thermal Power Plants*	149.9	152.3	151.2	153.3	157.1	159.4	163.6	156.2	164.9	163.4
Nuclear Power Plants	47.9	48.8	49.0	49.0	46.1	44.3	44.3	39.8	39.0	36.7
Hydroelectric Power Plants	46.5	46.7	46.7	47.0	47.5	47.5	48.0	48.5	49.1	49.2
New Energy	–	–	–	–	–	–	–	50.6	47.7	53.1
Total	244.4	247.6	247.8	249.2	250.7	251.1	255.8	295.1	301.1	302.5

*Includes geothermal power plants.
Source: Japan Electric Power Survey Committee (2009–2014), OCCTO (2015–2017)

Financial Data

Revenues and Expenditures for the EPCos

(Billion yen)

FY	2011	2012	2013	2014	2015	2016
Revenues						
Residential	6,143	6,393	6,919	6,967	6,460	3,960
Commercial and Industrial	8,330	8,892	9,888	10,373	9,356	5,654
Intercompany Power Sales	521	501	490	462	381	76
Power Sales to Other Utilities	96	106	194	262	215	338
Others	3,318	1,843	3,146	2,471	2,683	718
Total	18,408	17,735	20,694	20,545	19,093	11,632
Expenditures						
Personnel	1,434	1,339	1,257	1,213	1,257	952
Fuel	5,949	7,080	7,731	7,292	4,521	2,217
Maintenance	1,422	1,354	1,151	1,369	1,423	1,076
Interest Charges	345	350	356	358	301	184
Depreciation	2,026	1,890	1,928	1,861	1,839	1,214
Taxes and Public Charges	922	923	934	947	923	595
Intercompany Power Purchases	521	501	490	462	380	78
Power Purchases	1,976	2,260	2,504	2,763	2,834	2,198
Provision for (Reversal of) Reserve for Fluctuations in Water Levels	32	–14	–7	–6	46	1
Income Taxes	–106	–183	–47	183	243	90
Others	5,473	3,828	4,441	3,825	4,706	2,602
Total	19,993	19,327	20,560	20,269	18,473	11,207
Net Income	–1,585	–1,592	134	276	621	426

Note: The figures may not add up to the totals shown due to rounding.
Source: METI

Balance Sheet for the EPCos

(Billion yen)

FY	2011	2012	2013	2014	2015	2016
Assets						
Electric Utility Fixed Assets	23,934	23,893	23,329	23,253	22,859	15,685
Investment and Other Fixed Assets	13,781	13,094	13,279	12,849	12,788	7,757
Current Assets	4,751	5,604	5,924	5,652	5,001	3,052
Total	42,466	42,591	42,531	41,753	40,649	26,494
Liability and Net Assets						
Long-Term Liabilities	29,854	30,689	30,602	28,699	26,100	16,250
Current Liabilities	6,654	6,622	6,545	7,272	8,205	5,463
Reserves	139	128	125	122	173	171
Total Liabilities	36,648	37,439	37,272	36,093	34,479	21,884
Shareholders' Equity	5,759	5,048	5,154	5,513	6,074	4,484
Valuation, Translation Adjustments and Others	59	103	105	146	95	125
Total Net Assets	5,818	5,151	5,259	5,660	6,170	4,610
Total	42,466	42,591	42,531	41,753	40,649	26,494

Note: The figures may not add up to the totals shown due to rounding.
Source: METI

Uses and Sources of Funds for the EPCos

(Billion yen)

FY	2011	2012	2013	2014	2015	2016
Investments*	2,123	2,087	1,961	2,016	2,260	2,208
Debt Redemption	6,321	6,118	4,351	4,799	5,276	–
Total Required Funds	8,444	8,204	6,312	6,816	7,536	–
Source of Funds						
Bonds	70	1,434	1,302	877	637	
Loans	7,511	5,957	3,484	2,958	3,310	–
Total Source of Funds	7,581	7,392	4,786	3,836	3,947	–
Investment Breakdown						
Expansion Work	–	–	–	–	–	597
Improvement Work	–	–	–	–	–	1,496
Research Cost	–	–	–	–	–	8
Nuclear Fuel	–	–	–	–	–	104
Investment Total						2,208

*Includes nuclear fuel.
Note: The figures may not add up to the total shown due to rounding.
Source: FEPC (2011-2015), METI (2016)

Summarized Comparative Table Classified by Country for the Year 2015

	USA	Canada	UK	France	Germany	Italy	Russia	China	Korea
Total Installed Capacity (MW)	1,176,981	135,268	81,026	129,119	–	116,955	257,100	1,525,270	101,590
Hydroelectric	100,442	79,232	4,330	25,430	–	22,220	51,000	319,540	6,471
Thermal	878,525	34,148	53,967	22,335	–	65,938	179,100	1,005,540	67,754
Nuclear	107,360	14,033	9,487	63,130	–	–	26,300	27,170	21,716
Renewables and others	90,654	7,855	13,242	18,224	–	28,797	–	173,020	5,649
Total Energy Production (GWh)	4,077,601	631,192	338,917	546,767	646,888	282,994	1,067,540	5,740,000	547,802
Hydroelectric	243,989	373,845	9,037	59,079	24,898	46,970	169,910	1,112,700	5,796
Thermal	2,814,779	139,463	182,429	34,381	340,442	192,053	698,400	4,230,700	359,926
Nuclear	797,178	95,682	70,345	416,797	91,786	–	195,470	171,400	164,762
Renewables and others	221,655	22,202	77,105	36,510	189,762	43,971	3,760	225,200	17,318
Capacity Factor (%)	40.2	52.1	45.5	48.3	–	26.2	–	45.6	61.7
Total Energy Production per Capita (kWh)	12,707	17,606	5,359	8,490	7,904	4,655	7,439	4,176	10,778
Domestic Energy Supplies (GWh)	4,135,896	579,360	339,489	476,052	421,460	316,897	1,060,200	4,857,200	519,196
Energy Sales (GWh)	3,786,426	478,044	286,161	–	450,775	272,056	–	4,534,700	483,655
Number of Customers (At year-end; thousand)	150,081	–	30,038	36,761	–	37,639	–	–	22,030
Maximum Demand (MW)	741,056	95,507	52,753	91,900	77,992	60,491	147,000	797,730	78,790
Annual Load Factor (%)	61.1	65.6	68.3	59.1	61.6	51.1	78.3	81.7	72.6
Thermal Efficiency (%)	–	–	35.6	–	–	45.3	38.6	39.0	40.9
Loss Factor (Transmission and Distribution) (%)	5.1	–	8.0	7.5	6.1	6.2	–	6.6	3.6
Total Consumption per capita (kWh)	-	17,508	4,798	6,837	6,483	4,888	6,666	4,221	9,953

Source: JEPIC

JEPIC

Japan Electric Power Information Center, Inc. (JEPIC) marked the 60th anniversary of our founding in May 2018. Established in 1958 as a non-profit association of Japan's electric utility industry, our primary purpose is to meet the increasing need for systematic and sustained exchange of information with electric utility industries around the world. In response to government policy, JEPIC also initiated technical cooperation programs for developing countries in the field of electric power soon after our founding. These programs remain one of our main activities today.

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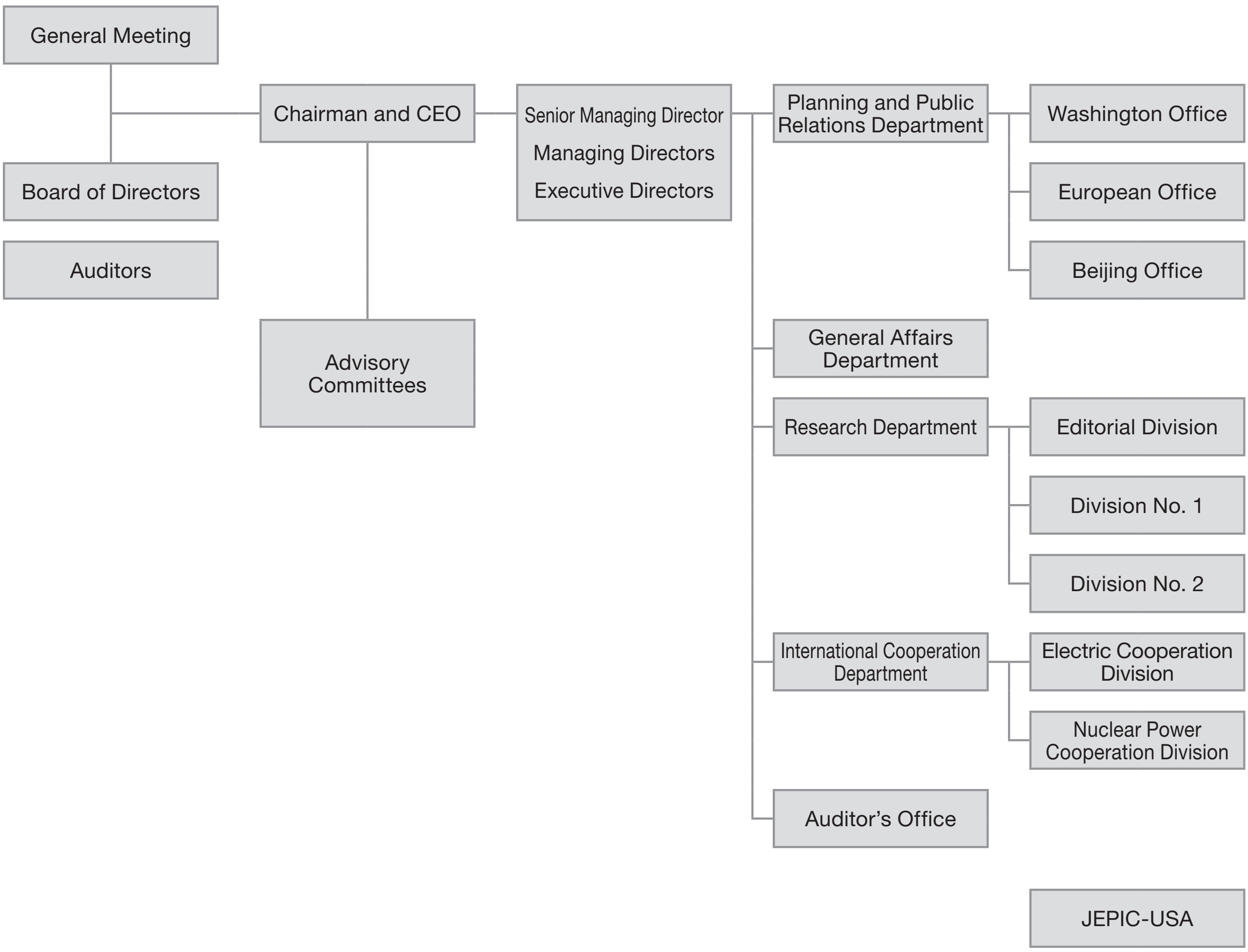

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